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JULY 2001

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Divided on Project 25

Ie the emerging fuel cell

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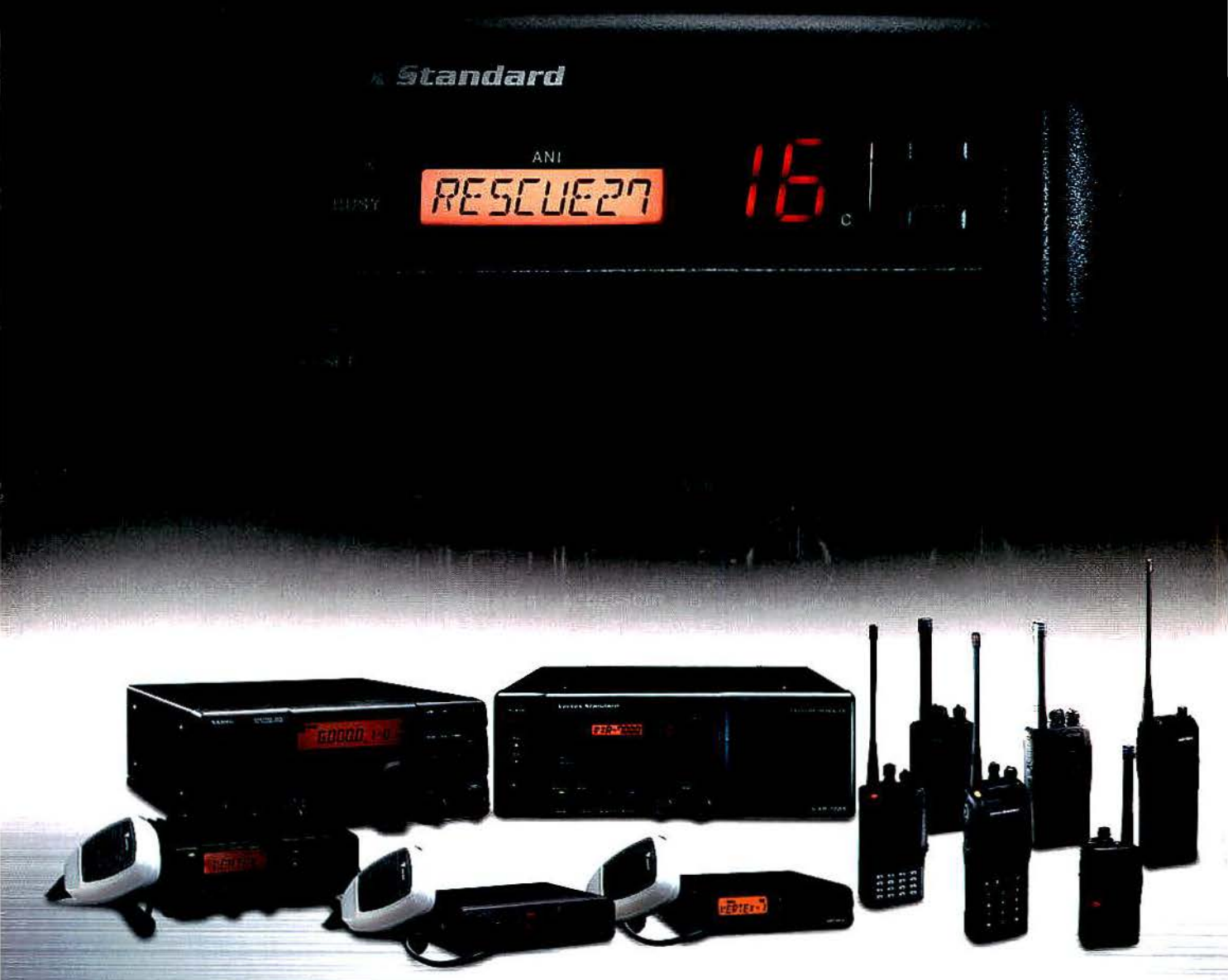

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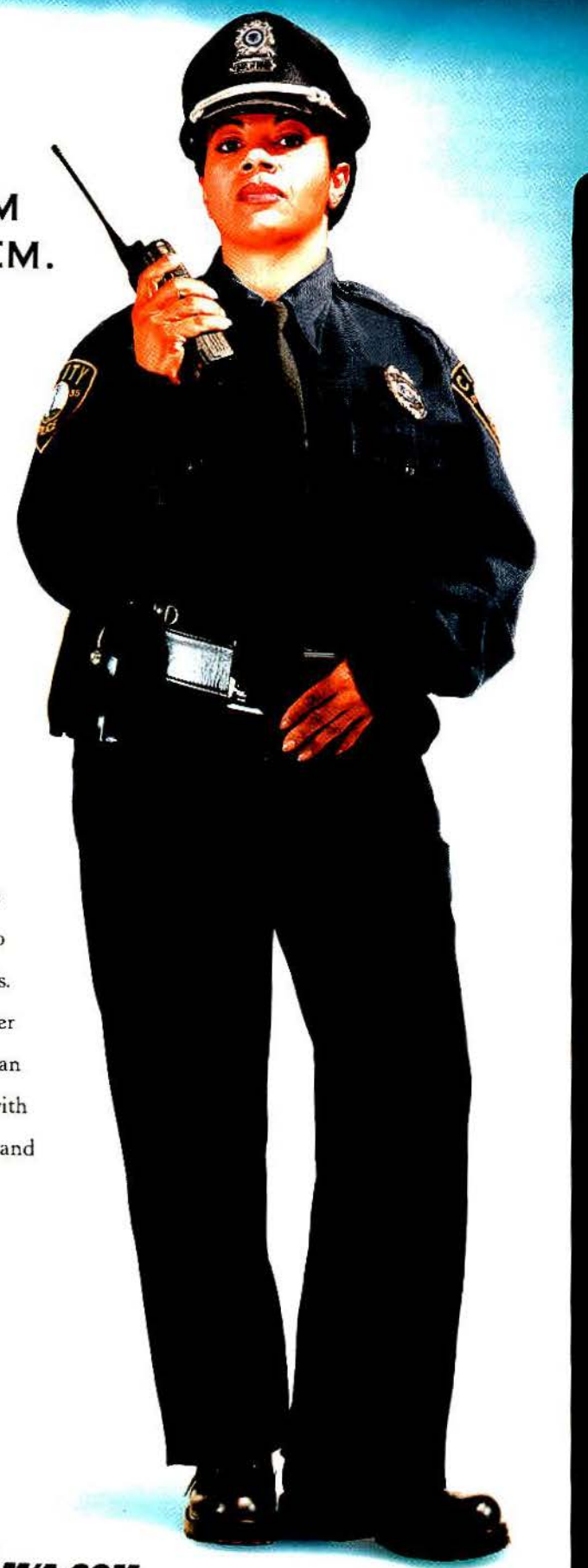

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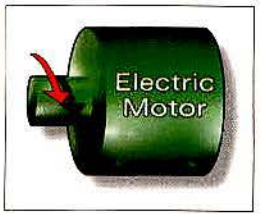
MRT
MOBILE RADIO TECHNOLOGY
JULY 2001
Volume 19, Issue 7

On the cover: Mapping RF hot spots involves a 15-minute walk around your site with portable GPS technology. Story on page 34.

TIA continues P25 discussion after Stephen Bartlett's article in April 2001 *MRT*. See page 18.

Features

***The Communicator*, A Product of *Mobile Radio Technology*:** If you are not receiving *MRT*'s new monthly newsletter via email, you can subscribe by emailing us at **mrt@intertec.com**. Just type "newsletter subscribe" in the subject line, and you will begin receiving *The Communicator*. The newsletter includes tidbits of information, such as background details about the land mobile radio business, cool links to nifty Web sites and magazine previews.



The fuel cell generator provides reliable, clean and quiet power. Will it eliminate the chemical battery? See page 40.

Departments

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CIRCLE (5) ON FAST FACT CARD

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Why not call a spade a spade?

Why does Robert H. Schwaninger Jr. not call a spade a spade? ("Diversification: A Case for Local Integrators," *MRT*, April 2000.) His term "local integrators" is simply a fancy word for "consultant." As learned as Mr. Schwaninger is, he is speaking from a totally different point of view than those of us he seems to be addressing. It is almost impossible to relate to our situation from his point of view.

Having operated an independent two-way radio dealership for the past 34 years, I fall into the exact category described by Mr. Schwaninger. The problem that he is not seeing stems from the old axiom that "an expert is someone from 50 miles away." This is the mindset that one cannot possibly know what they are talking about if they are "locals."

After having operated a dealership, one comes under immediate suspicion that one is biased when doing consulting work, and obtaining work in that line is extremely difficult. Potential clients view someone from "the trenches" as being narrow in viewpoint and as a collaborator with potential bidders on any project.

Although the bias is tough to deal with, another factor precludes really independent consulting work. How often do we seem to present a new project to the public to obtain support and public funding when the project has already been engineered, the vendor has already been picked, and the need for towers, antennas and facilities has already been decided?

By the time the client admits to his budgetary decision makers that there is a need, the consulting work has already been performed by the vendor with specifications written to exclude competition. Why should the client spend dollars for the independent advice of a consultant when the results might point to some other vendor for system implementation?

You don't ask for advice if you suspect you won't like the answer.

With all due respect to Mr. Schwaninger's experience in the industry, he most certainly (in my not-so-humble opinion) cannot relate to the actual conditions most of us deal with when making the change from hands-on to consulting.

—Jim Belanger

For Regulatory Consultant Robert H. Schwaninger's response, log on to www.mrtmag.com, and click on "Letters from readers."

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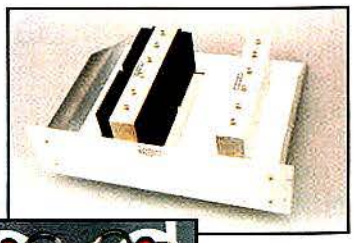

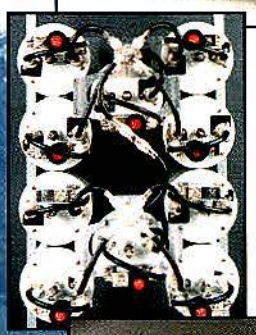

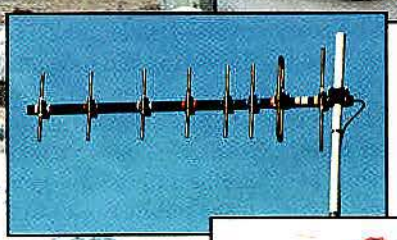

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CIRCLE (7) ON FAST FACT CARD

Earth to wireless carriers: Get serious about E9-1-1

Want to set a comm center/PSAP manager's teeth on edge?

Ask about wireless 9-1-1 calls. Ask whether the public safety answering

point's CRTs display location information from wireless phones.

Then watch the manager's jaw start working.

The FCC has required wireless carriers either to select and install network-based location equipment, or to sell and activate location-capable handsets. But carriers aren't taking FCC deadlines seriously enough. Or in the case of network equipment, some manufacturers may not be meeting federal requirements.

The good news: The nation's landline telephone system allows virtually all emergency calls to be placed to a single number. Important—some say, vital—information about the caller and the call's point of origin reaches call-takers and responders.

The bad news: Increasingly, emergency calls originate from wireless telephones. An estimated 25% of emergency calls in Connecticut originate from wireless phones, just as one example.

In May, the Cellular Telecommunications & Internet Association said wireless emergency service calls totaled more than 51 million in 2000—nearly 140,000 per day, or 96 per minute.

Currently deployed technology associated with emergency calls from these phones doesn't always reach the admirable standard set by call-handling systems for landline calls.

Wireless carriers that have implemented the FCC's Phase I requirements are prepared to deliver a callback number and cell site location information to PSAPs.

Phase II requires carriers to begin delivering more precise location information about wireless calls to the emergency number. For carriers wanting to use handset-based technology, the FCC requires them to begin selling and activating location-capable handsets on Oct. 1. This is where high-tech kicks in—along with high costs.

The carriers want someone—someone *else*—to pay for their costs. PSAPs want someone to pay for theirs. "Cost recovery" it's called in the business.

My landline phone bill includes an 18-cent E9-1-1 tax, but my wireless phone bill doesn't. How much tax would cover my local PSAP's costs? Wireless carriers' E9-1-1 cost recovery probably won't be listed separately, but the PSAP's might.

Enhanced 9-1-1—the 9-1-1 service that provides detailed caller information—is a partnership between government and industry. As government programs go, it's a good one, though it sometimes progresses slowly (as one could anticipate a government program might).

In the meantime, the AAA motoring and travel services organization has partnered with Airbiquity, a developer of wireless microdata delivery solutions, to field-test a portable location services device that attaches to existing cellular telephone handsets. AAA, which has been given quasi-public safety status in federal budget legislation, thus leapfrogs some wireless carriers and PSAPs. Not for public safety-type emergencies, mind you, but in offering "concierge" services to its members.

Test participants will call an AAA subsidiary, Response Services in Columbia, MD. Response Services operators will be able to view callers' precise locations on a computer map display, allowing them to effectively deliver roadside assistance, directions and navigation, directory assistance and other services.

The Airbiquity GPS accessory snaps in place as part of the battery. The blue button allows the user to send location information to AAA's response center.

PSAPs don't want "competition." And AAA doesn't want to attract public safety emergency calls. But if the public comes to know that an AAA Response Service operator can see where they are and a 9-1-1 call-taker might not, AAA might be fielding calls from people in more dire circumstances than it wants.

It comes down to teeth.

The FCC should put teeth into its deadlines for wireless E9-1-1 compliance.

Otherwise, the comm center/PSAP manager won't have any left.

Don Bishop

Editorial Director
dbishop@intertec.com
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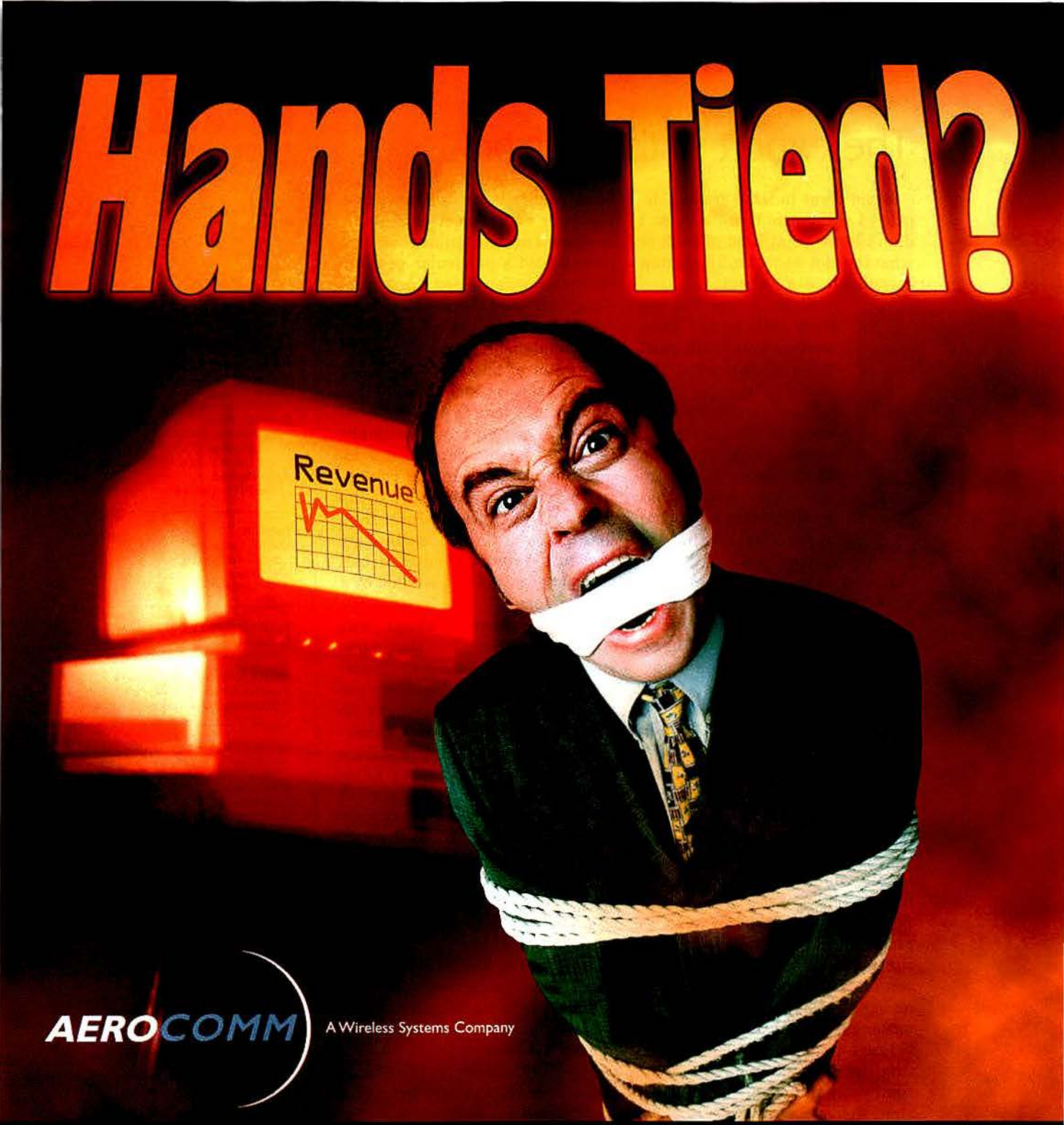
Hands Tied?



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CIRCLE (8) ON FAST FACT CARD

The expert in the mirror

When I was in sixth grade, I decided I wanted to write a book. I didn't know what kind of book or what the plot would be, I just knew I wanted to write a book.

Well, at age 25, the book still hasn't been written and I still don't have a clue what the plot will be.

How do you even go about finding a topic of interest to people? You know, those topics interesting enough that people won't put it down after reading the first two paragraphs?

Each month our magazine staff puts together features and departments that are timely, newsworthy and helpful to readers. Problem is, how do you know what people want to read? To answer that, we need feedback.

The "POS Perspective" column that runs in *MRT* every other month has generated passionate opinions, comments and suggestions from readers. Because you are enthused, we continue to run the column. But we still need more letters, comments and story ideas from you.

We need this input because we produce a monthly magazine, Web site and monthly newsletter to keep you up-to-date on news and information. Your input is helpful in determining future article topics.

I have a suggestion. Instead of letting the editorial staff figure out what you want to read in our magazine, Web site and newsletter, how about emailing me three topics you would be interested in reading a story about? It won't take longer than two minutes to think of the topics and write the message.

You could even write an article yourself. We would love to publish an article written about two-way radio dispatch or mobile telephone communications. Anything involving equipment and systems design, installation, operation and maintenance is useful knowledge. Use your experiences as a guide. Technicians and engineers who have solved a particular problem or who have developed a new technology are good storytellers.

What do you get out of it for your time and effort, you ask? As an author of an article for *MRT*, you will receive increased visibility that may lead to advancement within the company. You might improve the company image by demonstrating technical competence and capabilities. Or if the article is about a product, then you can explain the technology and functions in greater detail than what might be revealed by a press release.

If you're worried about your writing skills being less than superior, don't worry, we have editorial guidelines available. You also have us, the editors. After all, we do have to justify our jobs somehow.

If our readers send in topics and articles of interest, we know we're reaching our audience with pertinent information. Just keep in mind when choosing your subject that it should be broad enough for all our readers to relate to. What works for a base station engineer may not work for a tower builder.

Meanwhile, I'm gaining valuable research experience that will some day help me find an interesting plot and get me started on writing my book.

Maybe I'll start with "The night was humid as the radio technician approached his workbench..."

Kari Taylor
Associate Editor
ktaylor@intertec.com

"If it takes you seconds to diagnose a problem here, you're already late".

-Brad Brieman, Senior Network Engineer, Chicago Mercantile Exchange

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"I don't have a lot of time to second guess a problem. So, when I heard Anritsu developed a cable and antenna analyzer and spectrum analyzer all in one handheld unit, I had to get one.

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I recommend this product. If it can take on the bears and bulls in my field, I'm sure it can handle anything in yours." *-Brad Brieman*

For more information call 1-800-ANRITSU or go directly to our website product page at www.us.anritsu.com/adsmailers/s332b.asp. Site Master™ S332B. The preferred choice among leading network operators and service providers.

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Father knows cash

By Robert H. Schwaninger Jr.

The *Washington Post* business section is filled with interesting tidbits about local people who have climbed from parent-purchased MBA programs into positions that require multimodifying titles, like "Susan Vernal has been named Mid-States Regional Director of Sales and Product Identification Marketing for Schmengy Corp. of Chantilly, VA." My normal response is: Who cares?

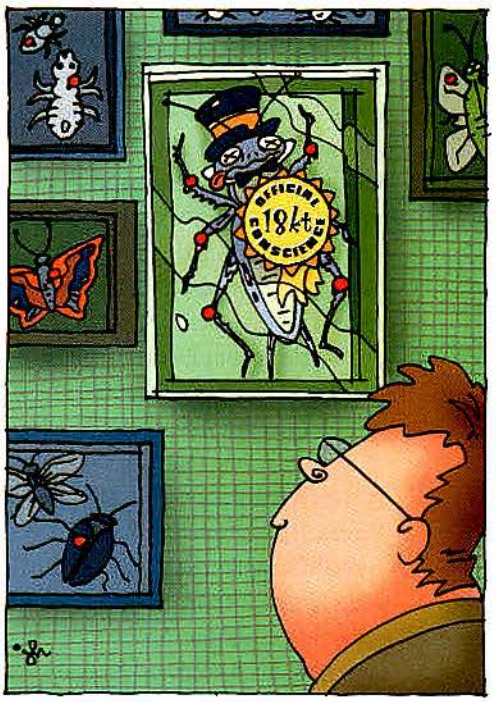

Illustration by John Hayes

"...BUT WHEN I BECAME A MAN, I PUT AWAY CHILDISH THINGS."

OK, Susan cares. Susan had to play the game and put her priorities in an order that didn't always reflect those values we were taught by Donna Reed, Ward Cleaver, Marcus Welby and any character played by Florence Henderson. So life isn't a '50s family show. We know that and yet, we hope.

Our expectations of how people should conduct themselves in their professional lives and the priorities that they should exhibit is altered if the people are government employees. Something about knowing that our taxes are paying their salaries raises our expectations.

We also know that government employees are not supposed to have a vested interest in the outcome of their decisions. There's that whole "impartiality" thing and that "no appearance of impropriety" idea that further piques our examination of officials' behavior. In fact, the feds have even codified the whole concept under Title 5 of the U.S. Code, which admonishes federal employees to be honest, polite and above reproach.

But then there are those influences that we know sometimes interfere with the noble goals articulated within the statutes. There's *politics*. The political agenda of the party in power, reflected in the decisions and operations of a federal agency, can dramatically alter the outcome and flavor of officials' decisions. Suddenly, the decisions are "pro" big business or "anti" regulation or whatever. The twists of logic, and the rewriting of facts that are used to justify this activity, are the stuff of legend.

Because people are people, even when they draw their pay from the federal government, these officials *know* when they have turned the facts into a logical pretzel and bent circumstances to fit a predetermined outcome. Although this contortion may assist them in their ambitions, there is an underlying defensiveness borne of embarrassment. They *know* they have lied or purposefully omitted material facts, and their consciences can hear their mothers saying, "Honesty is the best policy."

The people who work at the FCC *know* when they are engaging in

Schwaninger, *MRT's* regulatory consultant, is the principal in the law firm of Schwaninger & Associates, Washington, which is counsel to Small Business in Telecommunications. Schwaninger is also a member of the Radio Club of America.

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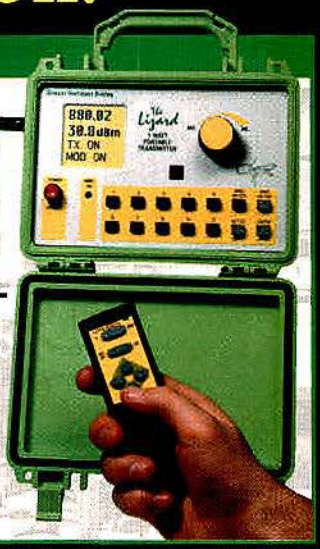

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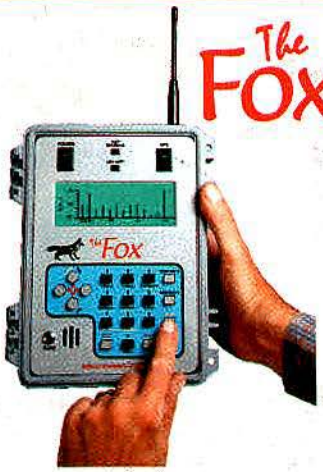

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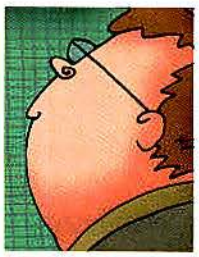
CIRCLE (10) ON FAST FACT CARD

delay, arbitrariness, political myopia, abuse of discretion or simple kowtowing to lobbying pressure. They know when they are serving a purely internal agenda that bears no resemblance to law, fact, logic or the public interest. And they dislike being reminded of it.

Said another way, they don't want a mirror held up that shows that the image they have cultivated bears no resemblance to the fresh-faced, bright-eyed child that used to win good citizenship awards in elementary school. That kid grew up, got smart and decided that there's little percentage in good citizenship for anybody on the FCC payroll. Heck, even when they *do* the right thing, they often do it for the wrong reason.

But we tolerate these abuses of power because there is little we can do about it. I once brought a case before the U.S. Court of Appeals that was grounded in my complaint that members of the FCC staff had engaged in abuse of power. The court tossed it saying, in effect, "You're a lawyer, and lawyers without a client can't complain because they are not directly injured." Great. The law states that the body of people with the greatest knowledge of abuse is not qualified to demand better.

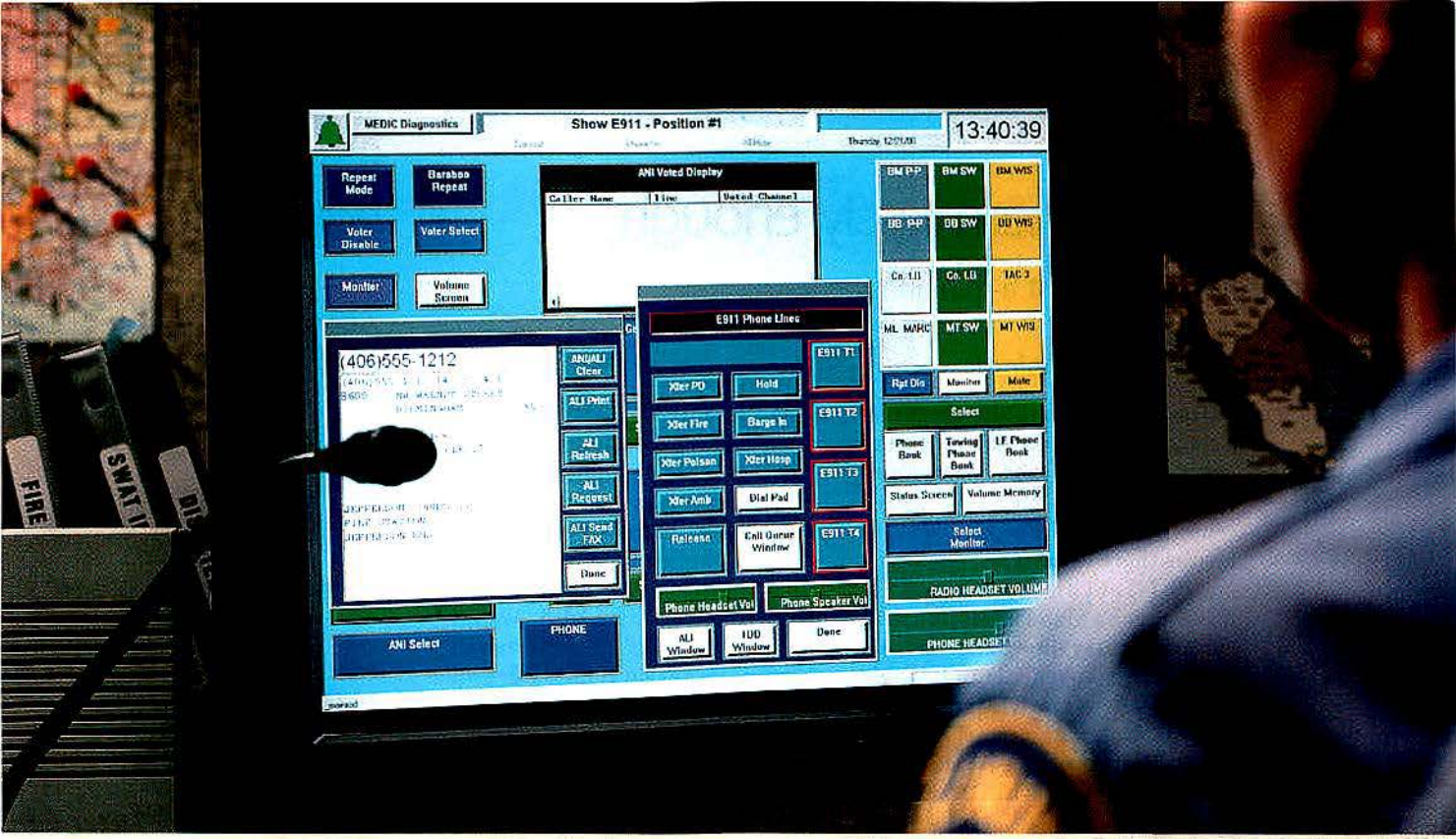
A further reading of the law shows that there is little in the way of a remedy even for non-lawyers. You can't get someone fired, fined or jailed for wrongdoing. That case would need to be brought by the U.S. Justice Department, and your chances of getting *it* interested aren't good. There is something wrong with a law that provides unfettered power to people while placing them beyond personal responsibility. It's especially onerous when those same people are charged with protecting the rights of individuals without regard to personal gain.



So, what happens to government officials who ignore the pleas of injured persons and turn a blind eye to evidence of agency chicanery? What happens when they rule in a manner that selectively benefits the few at the expense of the many, while all the time assisting in covering up the fleecing of the country so that a handful of politically connected, profiteering businesses can continue to engage in anti-competitive activity? I'm glad I asked.

This past week the *Washington Post* ran an article in its business section, announcing that former Chairman William Kennard has joined the board of Nextel Communications.

Irony? No. Just the final payment for a job well done. ■



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CIRCLE (12) ON FAST FACT CARD

It starts harmlessly enough

'Well, I was just a-thinkin' ...'

By David O. Dunford

Jim Gillihan was the chief dispatcher at the Lawrence, KS, Police Department back before there was such a creature as a "9-1-1 center manager." For that matter, he was there before Lawrence even *had* 9-1-1. (The department did have mechanized vehicles and running water, however.) During his roughly 35-year tenure at this hometown to the University of Kansas, Jim was relentlessly active in Kansas APCO. Actually, before APCO it was KLERA (Kansas Law Enforcement Radio Association), and Jim served in all of the elected positions. While not always quiet, Jim was unassuming about himself—but not about public safety communications. Jim was always looking at and working on ideas, suggestions, plans and improvements. These were what today we would euphemistically call "opportunities." And it always began in a conversation with "Well, I was just a-thinkin' ..." delivered in a sort of imitation hillbilly drawl. But Jim was already way ahead of "just a-thinkin'" by the time he started talking.

Being an employee of a public safety agency is a pretty good job—not highly profitable, but satisfying and rewarding, nonetheless. As I've mentioned before, an agency may expend more than 90% of its budget on personnel services. For anyone involved with issues of contemporary technology, this can make the job a real challenge. For all the reasons we've also discussed formerly, including operational goal setting, technical planning and financial forecasting, it is often difficult for public safety communications administrators to meet the basic goals of center management. Is is also difficult to embrace the climate of continual change that is both inevitable and, we hope, productive. So, when someone who was "just a-thinkin'" pipes up with a suggestion about a problem we didn't even know we had, it isn't always particularly welcome. After all, because center managers *solve* problems, aren't they the ones who get to *identify* them, too?

As it turns out (and as Radioman finally "discovers" after about 20 years on the job), nothing stays the same forever. Equipment may continually operate with technical proficiency, but its use (and the associated system) seems to be constantly changing in function or context. So what *is* Radioman Reality, after all?

Dunford, *MRT's* public safety consultant, is technical services consultant for the Lenexa, KS, Police Department. He is a member of the Association of Public-Safety Communications Officials–International. You can email Dunford at mrt@intertec.com.

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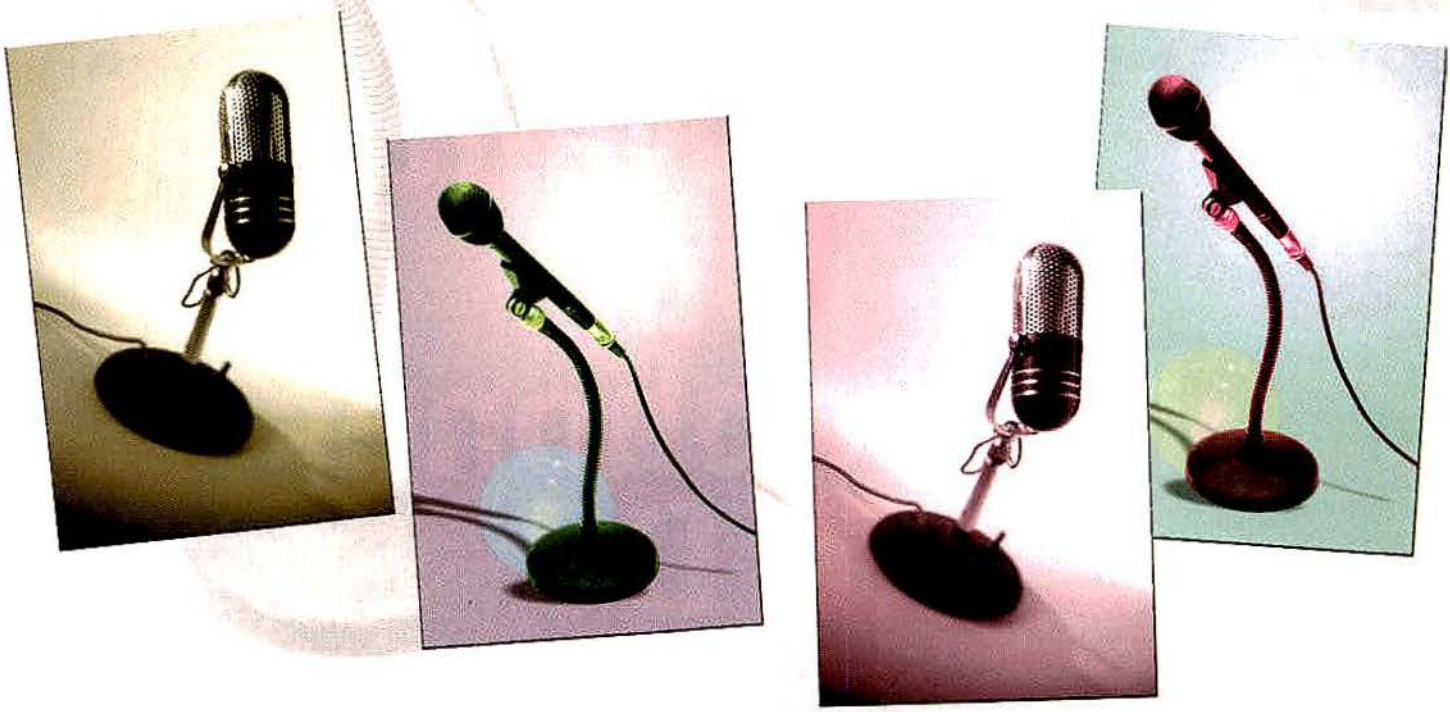
CIRCLE (13) ON FAST FACT CARD

When it comes to change, the simple reality is that Radioman can often spot it a mile away. Whether these changes arise from adjustments or agency policy, they are the result of someone who was "just a-thinkin'," or they arrive as regulatory mandates from people far away who are presumably much smarter. Radioman often has a technical foresight bordering on second sight. After all, to a technical person, changes involving a technical system are often obvious. But the other half of this reality is surreal: Occasionally, agencies embark on a course of change stimulated solely by the confusion of "motion" with "action." In these cases, poor Radioman will be led screaming (to himself) and kicking (only on the inside) toward an equipment change-out or a system replacement that he *never will* understand.

The missing part of this reality puzzle is that Radioman can, and rightfully should be, a "change agent" partner within the public safety agency. (This part is not a triumph in logic.) Additionally, though, (this is the hard part) Radioman should bring to the table a detached, objective viewpoint about technical issues (easy for Radioman) *and* agency operations (policy matters) that he is in a unique position to view. How many times, during the course of either a routine or late-night repair, does Radioman think of an idea, no matter how simple, for improving operations or furthering the cause of the agency?

It seems simple enough, this concept of helping to promote change for the sake of improvement, but often Radioman is seen only in the context of his own business interests or his involvement in the technicians' parallel universe. Overcoming this stigma is the hard part, but it's potentially rewarding for both the center manager and Radioman's commercial interests. So maybe we could take a cue from Jim Gillihan when we introduce our discussion with "Well, I was just a-thinkin' ..." And don't forget to speak slowly. ■

P25 debate: The digital standard revisited



The discussion continues on how performance criteria and propagation modeling should be applied to the Project 25 radio standard.

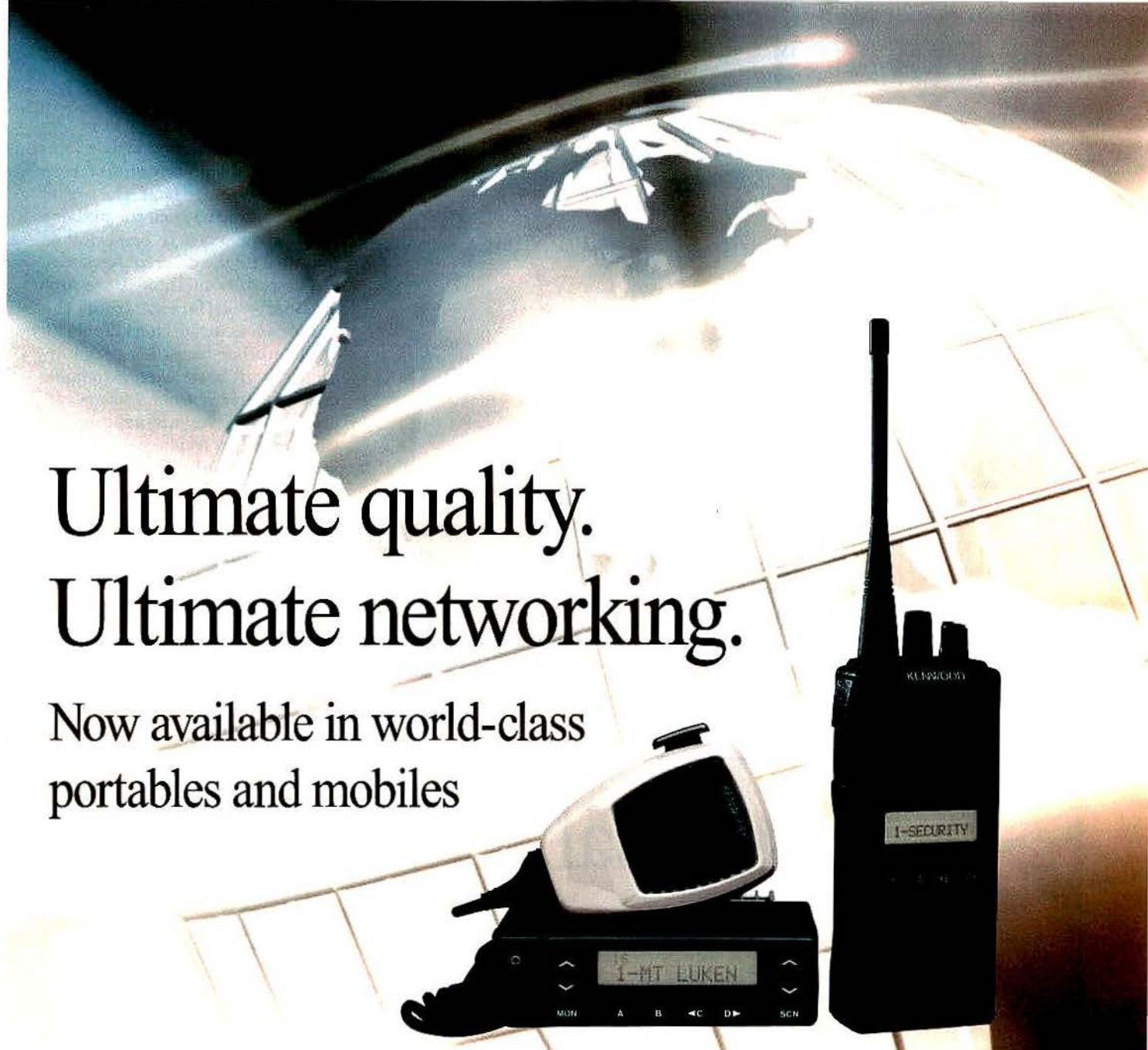
By Bernie Olson

Editor's note: MRT's *April 2001 article, "Does the Digital Radio Standard Come Up Short?" by Stephen Bartlett, drew strong response from the standards-creation community. A critique and technical assessment of the article has been prepared on behalf of P25 proponents by Bernie Olson, chairman of the Telecommunications Industry Association TR8.18 Committee on Compatibility and Interference. Following his analysis, we also present a further clarification by author Bartlett of his position.*

The article "Does the Digital Radio Standard Come Up Short?" does a gross disservice to Project 25. Although there are some good technical descriptions of each modulation, the author's comparison uses different performance criteria for the three modulations.

He then compounds the issue by using free-space propagation loss for a range comparison. Free-space loss is only valid for point-to-point paths where 0.6 of a Fresnel zone clearance is provided. In the land-mobile environment, this is commonly not the case. Therefore, the propagation power-loss exponent is closer to four than the free-space value of two, as used in the author's comparison. This use of different performance criteria and an extremely liberal propagation loss model has resulted in a distorted conclusion that cannot be supported in an actual land-mobile radio environment.

The flawed methodology used by the author is further aggravated by the use of information from different sources. The author did not acknowledge any disparity among the various reference levels, specifications or derived values from the different sources. Tables 1 and 2 on page 20 clearly show the difference between the assumptions used by the author and those embodied in TIA-TSB88-A. The first table shows the relative coverage range differences based on the criteria values



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CIRCLE (17) ON FAST FACT CARD

Table 1. Range comparisons.

Reference (modulation, IF BW)	Analog FM (65kHz) 12.6kHz	Project 25 C4FM 5.7kHz	Example π/4DQPSK 9.5kHz	Example π/4DQPSK 5.7kHz
Analog FM, 12.6kHz	1.0	1.25	1.19	1.35
C4FM, 5.7kHz	0.80	1.0	0.95	1.08
π/4DQPSK 9.5kHz	0.84	1.05	1.0	1.13
π/4DQPSK 5.7kHz	0.74	0.93	0.88	1.0

Table 2. Author's conclusions.

Reference	Analog FM (±5kHz) 12.6kHz	Project 25 C4FM 5.7kHz	Example π/4 DQPSK 5.7kHz
Analog FM, 12.6kH	1.0	<0.7	≈1.3

from "TIA/EIA Telecommunications Systems Bulletin TSB88-A, June 1999." These values are based on a propagation power-loss exponent of 4, more typical of land-mobile communications. The derivation of these values is presented later. The second table is extracted from the author's chart. The receiver IF bandwidth is indicated for the different scenarios.

The results in Table 1 are dramatically different from the author's conclusion chart (Table 2).

The author bases his range arguments on basic carrier-to-noise criteria derived from various references. However, when the author calculates C/N from receiver bandwidth and published receiver threshold "spec" data, he fails to account for receiver noise figure. One could leave receiver noise figure out of the picture and reference all performance to the receiver (demodulator) input, as the author attempts to do. This can, and does, distort the results unless a common noise figure reference is used.

Two receiver sensitivities (static

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CIRCLE (19) ON FAST FACT CARD

and faded) are given in TIA-102 publications. The static sensitivity is used to make laboratory or bench measurements. For analog radios, this benchmark is 12dB SINAD. For digital radios, this benchmark is 5% bit-error rate. Static sensitivity is not used in predicting coverage or range. It is used to ensure that the receivers have a published performance specification that customers can measure and use to compare receivers from different vendors. This is the receiver sensitivity value that normally appears on manufacturer's specification sheets.

The TSB88-A, TIA102.CAAA and TIA102.CAAB documents also include faded sensitivity values. There is no analog faded sensitivity standard, but the median of the values used by various system designers is 13dB above the 12dB SINAD value for performance. For digital radios, the typical value to achieve 5% BER in faded conditions is 6dB to 8dB above the 5% BER static sensitivity level. However, 5% BER in a faded environment is insufficient to produce acceptable audio. A lower BER is required to achieve acceptable audio quality levels, with 2.6% BER being considered the minimum design level for Project 25 digital radios using the IMBE vocoder.

Different scenarios

The author apparently used pieces of different specifications but failed to recognize the different scenarios these values are intended to represent. Also, many of the values cited for C/N are referenced relative to the receiver's "thermal noise threshold," which is the sum of the receiver's noise figure and the thermal noise-floor level based on receiver bandwidth. It appears the author assumes that the reference is just to the thermal noise-floor level.

▶ For example, in one reference the author cited the TIA102.CAAB performance recommendation, which refers to a static reference sensitivity of −116dBm at 5% BER. This value is correct. However, the author failed to include the noise figure of the receiver in his analysis. For example, a noise figure of 10dB would result in a required C/N figure of 10.4dB [−116dBm static sensitivity −(−136.4dBm thermal noise floor at 5.76kHz IF bandwidth +10dB noise figure)]. This figure is much closer to the 7.6dB value as shown in Table 3 on page 24. Furthermore, when one considers that TIA's specification is a "minimum" value and that manufacturers' equipment typically exceeds that figure by 2dB to 3dB or more, the Table 3 C/N value is confirmed.

▶ In another example, the information from the government Web site referred to by the author is accurate, but the author's interpretation is incorrect. The −121.4dBm level measured is for static sensitivity at

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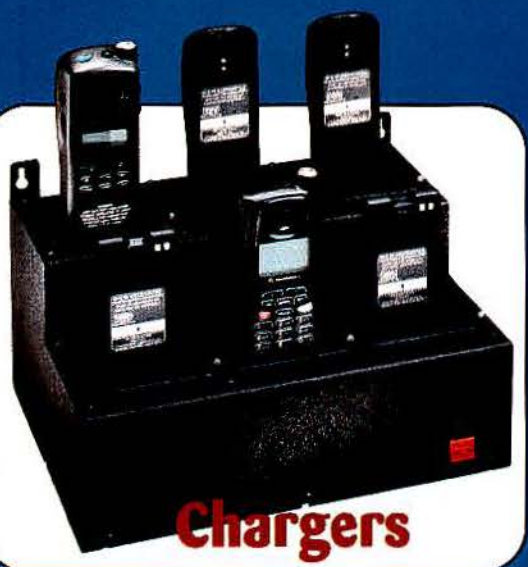

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CIRCLE (21) ON FAST FACT CARD

Table 3. DAQ for different modulations and receiver bandwidths (from TSB88-A).

Modulation type, (channel spacing) IF bandwidth	Static $ref / \frac{C_s}{(I+N)}$	DAQ-3.0 $BER\% / \frac{C_r}{(I+N)}$	DAQ-3.4 $BER\% / \frac{C_r}{(I+N)}$	DAQ-4.0 $BER\% / \frac{C_r}{(I+N)}$
Analog FM ±5kHz (25kHz) 12.6kHz ENBW	12dBS/4dB	N/A/17dB	N/A/20dB	N/A/27dB
Analog FM ±4kHz (25kHz) 10.1kHz ENBW	12dBS/5dB	N/A/19dB	N/A/22dB	N/A/29dB
C4FM (IMBE) (12.5kHz) 5.7kHz ENBW	5%/7.6dB	2.6%/16.5dB	2.0%/17.7dB	1.0%/21.2dB
π/4 DQPSK (IMBE) TDMA 9.5kHz ENBW	5%/6.9dB	2.6%/15.2dB	2.0%/16.4dB	1.0%/19.5dB

5% BER that occurs at 7.6dB C/N. This calculates to a receiver thermal noise floor of −129dBm, implying a receiver noise figure of 7.4dB (−129 − (−136.4)). The published static sensitivity for that receiver is −119dBm, so that particular receiver exceeded the manufacturer's published specifications by about 2.5dB.

▶ The author also misconstrued manufacturer's data. The level that was referenced (14dB) refers to the faded 5% BER, which is specified in TIA102.CAAB as being 8dB more severe than static conditions. Properly represented, this material would produce a calculated faded C/N of 15.6dB (8+7.6) relative to the receiver's thermal-noise threshold. However, these should accurately be portrayed as "minimum" values, even though typical measured values are between 6dB and 8dB. That brings the manufacturer's value of 14dB into the expected range.

▶ We cannot support the author's value of 6dB for analog FM. It lies somewhere between a static 12dB and 20dB SINAD. Under static conditions, it could be argued that this is a reasonable value. However, it would not be a representative value under faded conditions that delivers acceptable audio quality to the user. As indicated in Table 3, the recommended faded C/N value is 17dB,

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SS-25	20	25	2¾ x 7 x 9⅜	4.2
SS-30	25	30	3¾ x 7 x 9⅜	5.0

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SRM-12	10	12	3½ x 19 x 9⅜	4.7
SRM-18	15	18	3½ x 19 x 9⅜	5.0
SRM-25	20	25	3½ x 19 x 9⅜	6.5
SRM-30	25	30	3½ x 19 x 9⅜	7.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M	20	25	3½ x 19 x 9⅜	6.5
SRM-30M	25	30	3½ x 19 x 9⅜	7.0

MODEL SRM-30M-2

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SRM-25-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30-2	25	30	3½ x 19 x 9⅜	11.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30M-2	25	30	3½ x 19 x 9⅜	11.0

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SS-10V, SS-12V, SS-18V

CIRCLE (23) ON FAST FACT CARD

*ICS – Intermittent Communication Service

an 11dB difference before adjusting for filter bandwidth differences.

▶ We are particularly disturbed that only anecdotal evidence was presented claiming lower range from Project 25 C4FM, while range was represented as an absolute derived from empirical data. Many narrow bandwidth digital systems have been installed, and coverage is always greater than analog unless there is interference present*.

Published industry reference

We would encourage you to review the correct criteria values when making your own assessments. Those values are located and published in "TIA/EIA Telecommunications Systems Bulletin TSB88-A, June 1999." TSB88-A is a technical reference document developed in conjunction with the entire suite of Project 25 documents by a committee representing vendors, users, frequency coordinators and regulators. It was developed to provide frequency coordinators with the necessary information to determine frequency reuse as well as with a methodology for determining coverage range in the presence of co-channel and adjacent-channel interference. In that context, this information allows for the use of computer programs to evaluate potential frequency selections and to maximize coverage range while minimizing interference.

Because different digital modulations have different performance characteristics, a range of channel performances was developed, loosely based on the "circuit merit" definitions used for analog system evaluation. The definition is described as delivered audio quality and refers to:

- ❑ How easy or difficult it is to understand the intelligibility of a signal.
- ❑ Whether or not part of the audio is missing, requiring the message to be repeated, and if so, how frequently.
- ❑ What the detractors are, e.g., noise for analog or artifacts (distortions) for digital.

New systems are designed for a minimum DAQ of 3.0. A DAQ 2.0 is considered to be difficult to listen to, requiring considerable effort and frequent repetition for understanding. The higher DAQ values are defined for higher performance levels. They are defined as equivalent intelligibility to static SINAD values, but in the presence of Rayleigh fading (multipath), as experienced in actual usage.

*Interference has been increasingly evident in portions of the 800MHz band where nearby cellular/SMR deployments create coverage holes due to their high signal levels where the desired signal is relatively lower. Both digital and analog systems are affected, but digital systems will mute while analog systems may provide audible clues to a user. The absence of audible clues is frequently reported as a range problem. This topic was the cover story in *MRT*'s March 2001 Issue, "Why can't we talk? It's the interference." Visit www.apco911.org for a copy of the Best Practices Guide described therein.

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Table 4. Comparision of IF bandwidth noise power.

Denominator/Numerator	5.7kHz C4FM	9.5kHz π/4 DQPSK	12.6kHz analog FM
5.7kHz	0dB	2.22dB	3.44dB
9.5KHz	−2.22dB	0dB	1.23dB
12.6kHz	−3.44dB	1.23dB	0dB

Table 3, extracted from TSB88-A, shows the values for reference sensitivity (static C/N ratios) and the faded carrier to interference plus noise ratios, ($Cf/(I + N)$) for various DAQ values. The interference component, I, is included because interference is considered to be another detracting noise source.

It is important that a user or system engineer recognize that static conditions are only valid for bench measurements and are a way of comparing performance of individual units. By subtracting the Cs/N, the "noise floor" of the receiver can be determined. The $Cf/(I + N)$ then determines the signal level required in the presence of fading and other potential detractors.

For example, analog 12dB SINAD Cs/N is 4dB. If a manufacturer's published static receiver sensitivity is −119dBm, then the receiver's "thermal noise threshold" would be at −123dBm. If faded analog DAQ 3.0 Cf/N is 17dB, then the faded signal level for system design would be −106dBm (−123dBm thermal noise threshold +17dB Cf/N).

The width of the IF filter also needs to be considered. Wider IF bandwidths produce less distortion and better channel performance at lower Cf/N. However, this comes with a price because wider IF bandwidths are more susceptible to adjacent-channel interference and result in higher thermal noise powers in the receiver.

The author selected 14dB for C4FM (equivalent to a DAQ 2.0 [in fading]), the static value (7dB) for π/4 DQPSK and a static value (6dB) somewhere between 12dB SINAD and 20dB quieting for analog FM. It is difficult to conceive how three disparate criteria could be used to arrive at a uniform and accurate conclusion.

Comparing digital modulations

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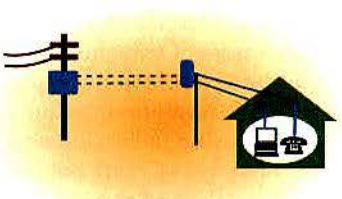

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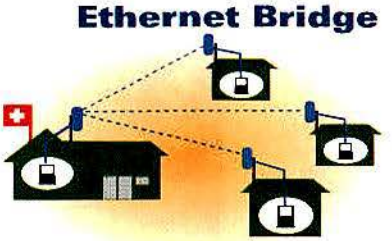

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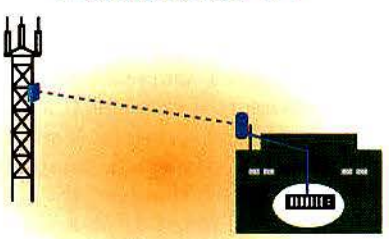
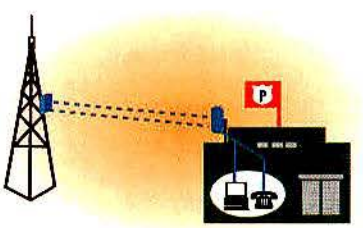


Transmits V.35 synchronous data between two sites for cellular backhaul or other point-to-point digital transmission. Uses just two watts and costs less than the competition.

Leased Line Emulator



Establishes a dedicated "nailed up" analog connection between two sites within 14 miles line-of-sight. Provides either two full-duplex lines or one 4-wire line.

All models feature:

- Plug-and-play simplicity. Small, lightweight, easy to install and use.
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- 2.4 GHz license-free operation.
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compatible four-level FM (C4FM) shows slightly degraded performance when compared to π/4 DQPSK, yet both have better performance than analog FM, particularly at higher Cf/N values.

As stated earlier, one should use a constant receiver noise figure reference. For the Table 1 analysis, the values were calculated assuming the same noise figure for all receivers. The comparison then becomes a simple matter of determining the difference due to bandwidth and the difference required for DAQ 3 and then calculating the relative ranges using a power exponent of 4.

$$10^{\frac{\Delta}{40}}$$

The differences between noise power of various IF bandwidths are indicated in Table 4 on page 28.

The difference in faded C/N between analog FM (17dB) – digital C4FM (16.5dB) = 0.5dB. (0.5dB + 3.44dB for the difference in the required receiver IF filter bandwidth = 3.94dB.)

The range difference using analog FM as the reference is:

$$10^{\frac{3.94}{40}} = 1.25$$

The difference using π/4 DQPSK is

$$10^{\frac{17-15.2+1.23}{40}} = 1.19$$

Taking the absolute best case where the π/4 DQPSK uses a 5.7kHz ENBW filter would produce a 1.35:1 ratio, an 8% increase over C4FM, but at the price of a non-compatible over-the-air interface.

The author discussed the distortion effects of transmitter filtering on the modulation. Typical π/4 DQPSK implementations use a raised cosine pulse shape with the pulse-shaping split between the transmitter and the receiver. This technique, called *matched filter*, can be shown to result in theoretically optimum sensitivity under Gaussian noise. Part of the Project 25 deliberations was matched filters vs. *pulse shaping*. Project 25 decided not to select a matched filter system but rather to concentrate all the pulse shaping in the transmitter. Doing this makes the modulation compatible with linear and constant envelope (FM) transmitters and receivers. A slight loss of sensitivity exists compared to π/4 DQPSK. However, the selected modulations, C4FM and linear CQPSK, are compatible in a Project 25 receiver. Thus. the receiver does not care if the signal is modulated with C4FM or linear CQPSK. This allows a 12.5kHz channel bandwidth transmitter using C4FM modulation to communicate directly (over the air) with a 6.25kHz channel bandwidth receiver as long as the center frequencies are aligned. This creates a migration path to narrowband 6.25kHz channel systems. This migration path

was encouraged and endorsed by the Project 25 user community.

Some of the author's comments about how digital technology degrades over-the-air-performance need to be considered and put in the correct context. Digital Project 25 radios have significantly greater range than analog radios for systems designed for DAQ 3.0 or above. At the fringe of coverage (below signal levels normally used for system design), digital begins to break down at a faded BER of about 8%. This is in the general range of 12dB to 14dB *C/I/N*. At these weak signal levels analog would still be understandable (with great effort) while the digital radio would mute.

However, migration to narrowband analog FM does not improve this situation. Analog FM doesn't perform as well in narrowband channels as it does in 25kHz channels. If narrowband analog is deployed, there is a 6dB degradation in performance from reduced deviation coupled with a 3dB improvement in receiver noise performance due to the narrower IF filter, resulting in a 3dB overall degradation. High-signal performance is reduced and a high SINAD cannot be achieved because some FM sideband information is lost passing through the narrow IF filter. Also, narrowband analog becomes more susceptible to noise pops, giving up the advantage that normal analog FM enjoys. ■

Muting thresholds: Stephen Bartlett's response

I appreciate Mr. Olson taking the time to offer his perspective on my article "Does the Digital Radio Standard Come up Short?" (April 2001, *MRT*), and his candor in pointing out several key issues he had with it.

I wish to clarify to Mr. Olson, and the mobile radio community, a misunderstanding about what my article was reporting. The study I described wasn't about the added range of *audio quality* that the P25 digital design achieves, but rather a discussion of the differences between the narrowband digital and wideband analog FM systems at the *edge* of radio coverage, or in other low signal-to-noise environments. As Mr. Olson pointed out, systems are not typically engineered for these fringe areas. However, it is under these conditions that radios will either mute or not, making coverage differences especially noticeable. The focus of my article was on how these different muting thresholds affect absolute range.

Mr. Olson is justified in suggesting the use of the number 4 for the power-law exponent describing the path-length dependency, in deference to the "extremely liberal" exponent of 2 that I chose. His figure reflects good engineering practice when designing mobile systems. It also reduces the scale of any range difference ratio.

He was correct to point out my not mentioning the receiver noise figure (*NF*) in the overall noise power (*Pn*) calculation. The correct formula is actually (neglecting interference):

$$Pn = 10\log(kT)\,\text{dBm/Hz} + NF + 10\log(BW)$$

For the analysis, I defined all receivers with equal and ideal NFs, but neglected to clarify this point. Where I erred was in assuming the manufacturer's specifications, and other measured data I used to compare with the 4-FSK model, did the same. Many published specifications don't clearly state whether their data are static *C/I/N*, faded *C/I/N* or if the receiver noise figures have been removed, included or normalized in their published values.

Muting thresholds will affect the coverage of the mobile radio system. Comparing these thresholds is the challenge. In his article, Mr. Olson stated that using a faded channel (Rayleigh fading) *C/I/N* ratio is more appropriate for modeling system performances than static *C/I/N* ratios. He also mentioned that no analog fading sensitivity standard exists, and he further recommended a faded value of 17dB for FM systems. This may be appropriate for determining a DAQ of 3.0, but not for a threshold mute. There are references showing critical wideband FM receiver thresholds are actually closer to 10dB; less with threshold extension (Rappaport, *Wireless Communications*). For digital systems, the mute threshold is defined by the critical bit-error rate where data cease to be reliably detected and vocoders to operate. It was good of Mr. Olson to recommend using the more realistic 2.6% BER threshold value for the IMBE vocoder to deliver more accepted audio in a faded channel. However, because of the focus of my article, I chose the 5% BER value as the digital mute threshold.

For a more complete approach in determining the expected faded channel performance for the digital systems, refer to J. Proakis' book *Digital Communications, Fourth Edition*, where the ideal theoretical performances of many common digital modulation schemes in a Rayleigh faded channel are derived. In such a channel, the error rates vary inversely with signal to noise—unlike static exponential error behavior. In the case of *binary, noncoherent, orthogonal* FSK modulation, a *C/I/N* value can be found directly from the probability of error (*Pb*) using the Rayleigh channel formula: *C/I/N* (dB) ~ 10log (1/*Pb*). We can use this equation to calculate the *C/I/N* performance for any FSK signal at 5% BER. *Orthogonal* binary FSK and 4-FSK channels will perform nearly identical *except at low C/I/N*. Therefore we can use the Rayleigh formula to estimate C4FM's average departure from ideal performance in weak signals due primarily to its nonorthogonal four-level modulation.

Mr. Olson reported that in the faded channel, C4FM will break down in the fringe areas with 8% BER at a *C/I/N* of 12dB to 14dB. The Rayleigh channel formula predicts the ideal binary FSK *C/I/N* value at 8% BER to be 11dB. Thus, Mr. Olson's 8% BER value shows that C4FM has from 1dB to 3dB of degradation (2dB average) from ideal. From this, we can determine the optimal *C/I/N* mute threshold for C4FM modulation at 5% BER:

$$C/I/N = 10\log[1/(0.05)] + 2 = 15\text{dB}$$

Using this optimal C4FM mute threshold of 15dB, the referenced wideband FM mute threshold of 10dB, and the bandwidth adjustment of 3.44dB, an absolute range difference between the digital C4FM and wideband FM analog systems can be calculated, using the equation recommended by Mr. Olson:

$$\frac{r_{C4FM}}{r_{FM}} = 10^{\frac{10-15+3.44}{40}} = 0.91$$

This 0.91 value shows a potential loss of absolute range between the C4FM digital and wideband FM analog systems, due to their different muting thresholds. Realistically, in the unpredictable faded channel with the parameters of analog and digital modulation being so different, there may be a variety of cases where either system may outperform the other, perform nearly the same or vacillate between these extremes—especially in fringe areas where muting occurs. It is in the best interest of the community to know how these digital narrowband systems perform in a variety of locations and scenarios as they become more widely implemented. If problems can be predicted early, they can be mitigated early.

—S. Bartlett

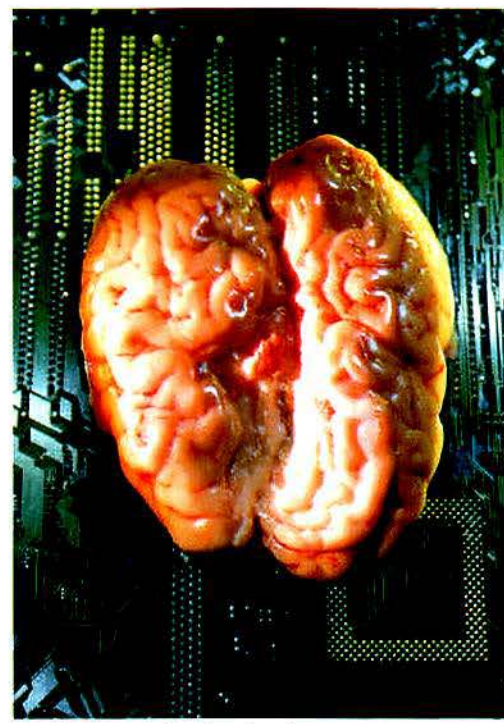
Radio troubleshooting: Hardware & software

By Harold Kinley

I have a theory about troubleshooting radio gear or, for that matter, any type of electronics. Troubleshooting involves the use of *hardware* and *software*. I don't mean *computer* software and hardware—although these items have become an integral part of land-mobile radio servicing. The *software* to which I refer is the old gray brain matter. The *hardware* comprises multimeters, wattmeters, service monitors and all other such equipment, including simple hand tools.

Someone in the land-mobile radio business once said that a proficient troubleshooter can fix more problems with a few simple devices than a less-proficient technician can with a multitude of the finest test equipment. A highly proficient *radiotech* (an adaptation of "radioman," but without gender) can fix more stuff in a day (read: Earn more money for the shop) with a multimeter, a soldering iron, a screwdriver and a pair of pliers than a radiotech "wannabe" of less ability can with an array of test equipment including a communications analyzer, a spectrum analyzer and everything in between.

The difference lies in the *software*. The ability to troubleshoot is a *gift*. If someone has no innate ability to troubleshoot, then no amount of training will make that person a real troubleshooter. It has to do with *mentality* (not to be confused with IQ). It's a state of mind. Some people just have an ability to analyze data and information and come up with a logical conclusion based on an analysis of that collected data and information. Not everyone has this ability, and (in my opinion) it can't be taught. You either have it or you don't.



Radio troubleshooting involves using your mind as well as multimeters and screwdrivers.

So, does that mean that we should abandon training? Absolutely not. Radiotechs who have this innate ability to analyze data to troubleshoot electronic equipment still require training. The difference between a good land-mobile radio troubleshooter and a *great* radiotech is training. Knowledge of the equipment and operating principles used to analyze equipment malfunctions is acquired through training. Unless the radiotech knows how the equipment is *supposed* to normally function, it will be difficult to apply logical troubleshooting analysis to that equipment when it malfunctions.

Test & measurement procedures

All radiotechs must perform certain test-and-measurement procedures to understand the operation of the particular piece of equipment being analyzed. Many test-and-measurement procedures have been developed and standardized over the years by various organizations, including the American National Standards Institute, the Electronic Industries Association, the Telecommunications Industry Association, the National Institute of Justice, the Institute of Electrical and Electronics Engineers and others.

Of greatest importance to land-mobile radiotechs is TIA/EIA document 603-1. It includes all standardized test-and-measurement procedures that are pertinent to the performance testing of land-mobile radio equipment. This document (well, *book*, actually; it's nearly 300 pages) is available by writing to: Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5704, or by calling: 1-800-854-7179. The Web site address is **www.global.ihs.com**.

Specifications that are found in land-mobile radio equipment technical manuals are based on this document. To ensure that equipment meets or exceeds the published specifications, certain test-and-measurement procedures must be performed on that equipment. These test-and-measurement procedures must conform to the standard procedures laid out in documents such as TIA/EIA 603-1.

Standard procedures exist for measuring receiver sensitivity and selectivity, transmitter power output and frequency, spurious output and all other pertinent criteria

Contributing editor Kinley, *MRT's* technical consultant and a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual, with Instrumentation and Testing Techniques,* which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301. Kinley's email address is hkinley@home.com.

associated with radio performance.

In general troubleshooting, it isn't always necessary to follow the standard test procedure for a particular test or measurement. But when you want to compare the result to the published specification, make sure that you follow the standard procedure to the letter. We want to compare apples to apples and not apples to oranges.

Getting back to the theory of a radiotech, it may not be possible (even with intensive training) to make a proficient troubleshooter out of just anyone who comes along. But training can turn a fair or good troubleshooter into a better one. Also, a good troubleshooter might get the job done with minimal test equipment, but imagine what that same radiotech can do with great test equipment.

A good radiotech approaches a job with an open mind, a knowledge of the equipment and the necessary test devices in hand. Never decide what is wrong with the equipment and then set out to prove your theory before you arrive on site. Let your test procedures guide you, logically, to the problem. You must have confidence in your equipment and in your test procedures—otherwise the time and effort is wasted. Divide and conquer is a fundamental principle of troubleshooting. If your test-and-measurement procedure(s) lead you in a different direction, don't be reluctant to move in that direction.

As a young troubleshooter, I was working with a mobile radio on the bench. All test-and-measurement procedures indicated that a particular capacitor was defective. It was in a nearly inaccessible location on the board, and it looked like a new one, anyway. So, I wasted time trying to prove that the trouble *wasn't* the capacitor. Yet, all logical test procedures still led to the same capacitor. Finally, just to prove that the capacitor wasn't bad, I removed it from the board to test it out-of-circuit. Of course, it was leaky. Replacing that capacitor cured the trouble. The extra time spent wasn't a total waste, though, because I learned from that experience.

The angle of attack has evolved over the years from troubleshooting down to the component level to troubleshooting down to the board. Now, we seem to be more involved with *system* troubleshooting. Whatever type of troubleshooting you do, the basic principles remain the same. Approach each job with an open mind, and let your test-and-measurement procedures be your guide. Anyone can replace a bad part to fix a broken radio, but it takes a real radiotech to find *which* part is bad.

Until next time—*stay tuned!* ■

Trot to hot: Mapping RF exposure

Portable GPS technology offers a quick way to do a site compliance survey and to map out hot spots.

By Paul Naumann, P.E.

The RF meter shares the same mast as the GPS receive antenna.

Taking a stroll around your site can be good for your health—and that of other people. Whether you are trying to protect people from health hazards, eliminate interference or simply comply with the FCC's OET Bulletin 65, three-dimensional mapping of the actual electric and magnetic fields to determine RF exposure compliance can be simple and accurate. The process involves combining portable GPS equipment, compact RF measurement equipment and standard computer software.

The problem

Few will argue—documenting RF exposure compliance in a multi-transmitter environment is difficult. Many parameters are tricky (if not impossible) to determine, such as reflection points; near-field, far-field and transition regions for each antenna and frequency; antenna patterns; downtilt and transmit duty cycle. Computer modeling software can simplify the process. However, the de facto standard for the software is to simplify using "worst case" analysis, which greatly overestimates field strengths.

Overestimating field strengths can result in unnecessary transmitter and antenna modifications. A case in point is a standard 2GHz microwave transmitter (1W) and eight-foot diameter antenna. Computer-modeling software typically results in a general-population exposure problem directly in front of the antenna when, in fact, the highest measured electric field on the surface of the reflector is about 12V/m, or plane wave equivalent power density of 0.04mW/cm^2. With a power density exposure threshold at 2GHz of 1.3mW/cm^2, 0.04mW/cm^2 equates to only 3% of the maximum possible exposure general population standard (FCC OET Bulletin 65, Edition 97-01, Table 1B). The only possible exposure issue would occur between the reflector and the feed horn.

With a radome, an exposure problem is simply not possible. A general misconception is the larger the reflector, the higher the ERP

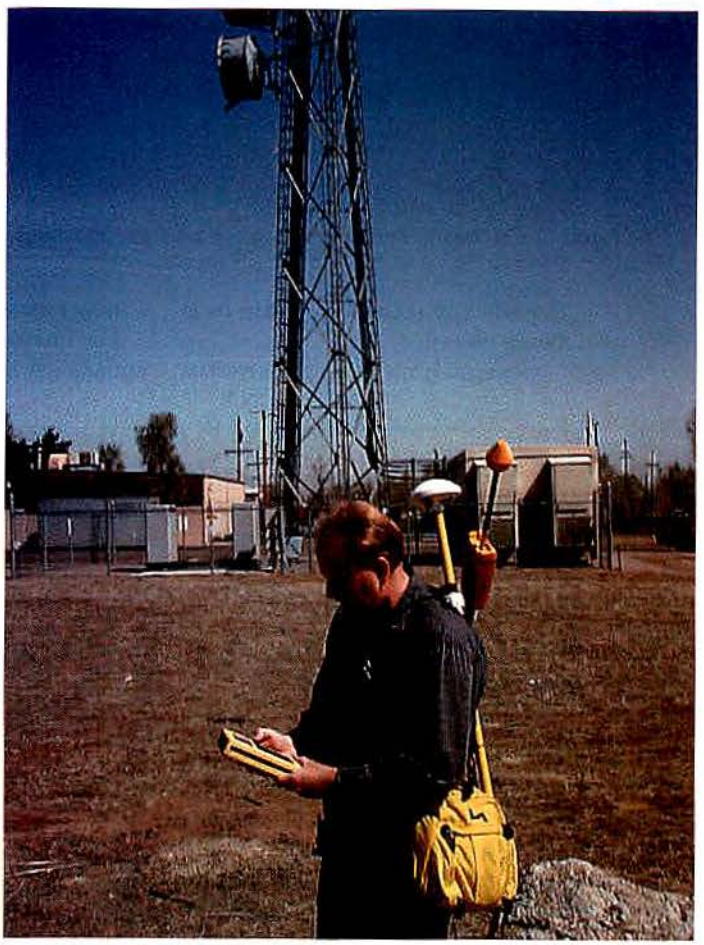
Paul Naumann is an engineer for IBM in Denver and consults privately as a licensed professional engineer.

and the greater the exposure hazard. In reality, the larger the reflector, the lower the exposure because the power is dispersed over a greater area. A quick analysis of the formulas presented in FCC OET Bul. 65 will prove that a 6GHz or 2GHz aperture antenna operating under 4.4W, or a reflector greater than four feet in diameter will not create a general-population exposure problem at any location.

The greatest exposure issue with most private communications systems is rooftop-mounted, high-power, VHF transmitters feeding small-aperture antennas such as a simple folded dipole. VHF transmitters normally operate at a much higher output power level. The exposure standards are also most stringent in the VHF frequency range, and the smaller antenna concentrates the field in a smaller area.

The solution

What is the solution to determine and document FCC compliance for complex, multitransmitter environments? Combine calibrated RF test equipment with a portable GPS receiver, data logger, standard PC software, and 15 minutes of footwork (see Figure 1 on page 36). The result is an accurate map of the actual electric and magnetic fields at a communications site—basically a *micro* coverage map of the actual electric and magnetic fields, which can be represented as a 3-D bar graph or scatterplot (see Figure 2 on page 38). A quick statistical analysis of the data can also provide the site average, the standard deviation and the exact location(s) and magnitudes of the peak field measurements.



A 15-minute walk around the site produces about 600 data points.

The overall process is to *walk* all areas of the communications property with a portable GPS receiver and RF radiation monitor while a portable data logger automatically creates an electronic file of latitude, longitude and field-strength measurements in one-second time increments. Normally, the site is walked three times, with different probes for: electric field, magnetic field below 30MHz and magnetic field above 30MHz. As seen in the above photo, a 15-minute walk around the site will produce about 600 data points. GPS signal blockage from buildings and foliage will

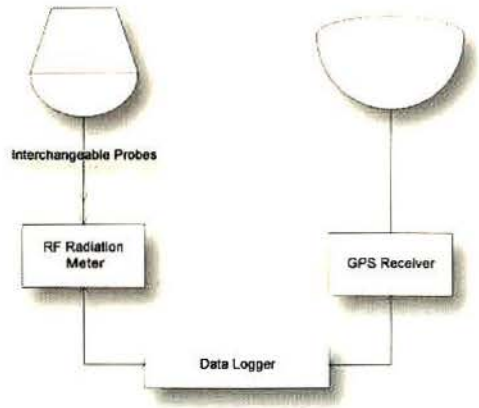


Figure 1. Combining equipment to make a survey apparatus.

periodically stop data points from being recorded.

Separately measuring the electric and magnetic fields eliminates any concern for near-field and far-field considerations. The GPS data are then:

- ❑ downloaded into a PC, differentially corrected with a GPS base station.
- ❑ exported into a standard spreadsheet to gather statistical information.
- ❑ exported into a gridding and plotting program.
- ❑ exported into a CAD program for plotting and sizing.
- ❑ ultimately analyzed for areas that may exceed the MPE standards.

For increased accuracy, it is recommended that the measurements be done during a busy hour, or performed at different times of the day. A typical electric field survey under a communications tower with land-mobile radio will result in a maximum electric field of about 1.5V/m, an average of 0.25V/m, a standard deviation of 0.29 and 600 data points.

To implement the process, the first step is to purchase hardware and software that is compatible and accurate. The RF measurement equipment should be traceable to a calibration standard, and it must have a communications output port, command language and protocol that is compatible with the GPS data logging equipment. This will be the most time-consuming and difficult step.

The RF equipment must be capable of sending, on request, field-strength measurements in one-second or quicker increments. The GPS data logger must be able to send the proper command to the RF

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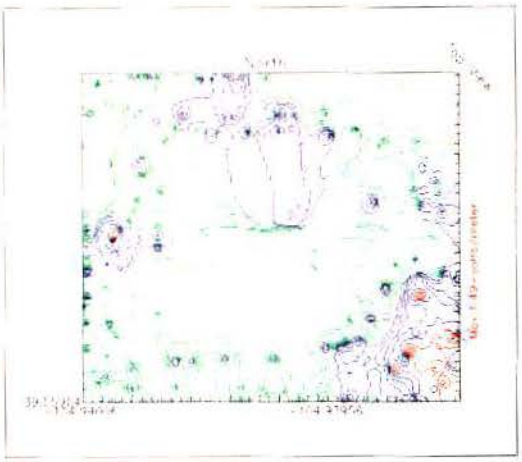


Figure 2. The micro coverage map can also be represented as a scatterplot.

equipment, and instantaneously store the received measurement with the GPS location. The GPS receiver data must have the ability to be differentially corrected to sub-meter accuracy.

For convenience, it is possible to mount the RF meter on the same mast as the GPS receiver antenna. This locates the probe at a high location and away from the body for more accurate measurements.

With the data-collecting system operating properly, the next step is to gather actual data, electric and magnetic fields, and download them into the software normally supplied with the GPS receiver. The accuracy of the latitude and longitude data is then increased to sub-meter by downloading GPS data through the Internet from a GPS base station. This process, known as *differential correction*, is essential for the small increments of distance used in a small site survey. Differential correction is based on the fact that errors in a GPS signal are common to all receivers within a radius of several hundred miles. If a base station is placed on a known reference point, software can then *factor out* the common error between the base station and the rover GPS data.

Most important: Keep your own safety in mind. Always wear a personal safety RF monitor during all site surveys.

The data are now ready to be exported into a common spreadsheet and cleaned up into a simple X, Y and Z format. The rows represent samples taken at one-second increments. The three columns represent latitude, longitude and associated field strength. At this point, it is convenient to record the maximum field strength and its associated location, the number of samples, the average and the standard deviation. If the maximum recorded field strength does not approach the MPE threshold, the results can be documented with no further action (see Figure 3 on page 39). However, if the MPE is exceeded, the actual field intensity can be mapped to determine the actual location(s) and/or transmitters.

To continue with plotting, the X, Y and Z data are exported into a contouring and 3-D surface mapping program, which ultimately creates a *DXF* or *DWG* file for export to a computer-aided design program. First, the random field data must be converted into a well-defined grid. This requires the selection of an interpolation method and the number of final points to plot. A grid size of 125 × 125 creates an excellent plot. The interpolated grid can now be exported into two basic types of programs for plotting—a 3-D surface contour and a topographical type representation. Text, color levels, scales and discrete locations can be defined and added to the plot. From the 3-D and topographical programs, the data are exported to CAD for sizing, plotting and adding legends. The plots can be analyzed for location(s) that exceed the MPE, and a correlation can be determined between the field intensities and the source transmitters. The plots are also useful for determining locations that may require grounding, shielding or signage. They can also be used in formal presentations for zoning hearings.

Lessons learned

- ❑ Be careful of magnetic field data below 30MHz. Sources can include pad-mounted power transformers, power-distribution lines, and vehicle loop sensors that may not contribute to the RF environment. Limit the probes for the frequency bands in use at the site.
- ❑ Turn off automatic zero calibration after the initial meter calibration. This function can result in *zero* data points during a survey.
- ❑ Allow the probes and test equipment to acclimate for 30 minutes prior to performing a survey.
- ❑ During data collection, regularly verify received data from the RF equipment because cables can be easily disconnected.
- ❑ Consider gathering GPS data for the corner of buildings and towers to orient plots to physical reference points.
- ❑ During the gridding process, select an interpolation method that creates smooth contouring, such as Kriging, search method octant, with several points.
- ❑ Don't rely on the data logger to retain information. Download the data to a PC and verify prior to leaving the site.
- ❑ Most important: Keep your own safety in mind. Always wear a personal safety RF monitor during all site surveys.

Baseline for future reference

For RF exposure compliance, there is a decision point where field measurements are much easier than computer modeling, and automating the process for data collection can greatly increase accuracy, decrease expenses and accurately document FCC compliance. The combination of GPS technology with RF measurement equipment can often be the best solution for determining compliance at locations with multiple transmitters and antenna configurations.

This method of data collection is an excellent method of establishing

MPE Site Survey Record
H-Field 27 MHz - 1 GHz

Form Update: April 6, 2001

		Units
Site/Transmitter Name:	SNCC	
Location:	Property	
Date:	March 27, 2001	
Maximum Measured Site MPE:	***28.0***	**%**
Maximum Measured Field -	0.0206	amps/meter
Location -		
Latitude:	39.86759706	degrees north
Longitude:	104.8993518	degrees west
Average Field Magnitude:	0.005	amps/meter
Standard Deviation:	0.0042	
Limit for Maximum Permissible Exposure (MPE), General Population, Per FCC OET Bulletin 65, Edition 97-01, Table 1(B), 30-300 MHz (most stringent):	0.073	amps/meter
Data Collection -		
Engineer/Technician:	Paul Naumann	
Start Time:	11:08	AM
Stop Time:	11:16	AM
Number Corrected Samples:	307	
Test Equipment -		
EM Radiation Meter -	Wandel & Goltermann	
Model:	EMR-300	
Serial Number:	AB-0050	
Calibration Certificate -	22443100AB00500051	
Date:	December 11, 2000	
Confirmation Interval:	24	months
Traceable to General Conference on Weights and Measures (CGPM), ISO 9001, ISO 10012-1		
Probe -	Wandel & Goltermann	
Type:	TYP-10, H-Field 27 MHz - 1 GHz	
Serial Number:	Z-0028	
Height Above Ground:	6	feet
Calibration Certificate -	22449026-Z00280102	
Date:	September 20, 2000	
Confirmation Interval:	24	months
Traceable to General Conference on Weights and Measures (CGPM), ISO 9001, ISO 10012-1		
GPS Receiver -	Trimble	
Model:	29654-01	
Serial Number:	220095483	
Data Logger -	Trimble	
Model:	3300-CPCH0PE-011	
Serial Number:	H084923	
Differentially corrected to sub-meter accuracy		
Differentially Corrected Source Data File:	R032718Acor	
Time Averaged Measurements -		
Location 1:		
Six minute average:		amps/meter
Location 2:		
Six minute average:		amps/meter
Location 3:		
Six minute average:		amps/meter
Notes:		

Figure 3. A Microsoft Excel spreadsheet or similar program can be used to assemble the data.

a *baseline* for the overall noise floor of a communications site and could be invaluable information for troubleshooting desensitization problems and site-sharing arrangements. A future application to explore would be taking the equipment mobile and mapping antenna farms or entire shared mountain-top locations. ■

How ready is the fuel cell?

Emerging portable power technologies are poised to provide more efficient hand-held energy. It's not your father's battery anymore.

By Isidor Buchmann

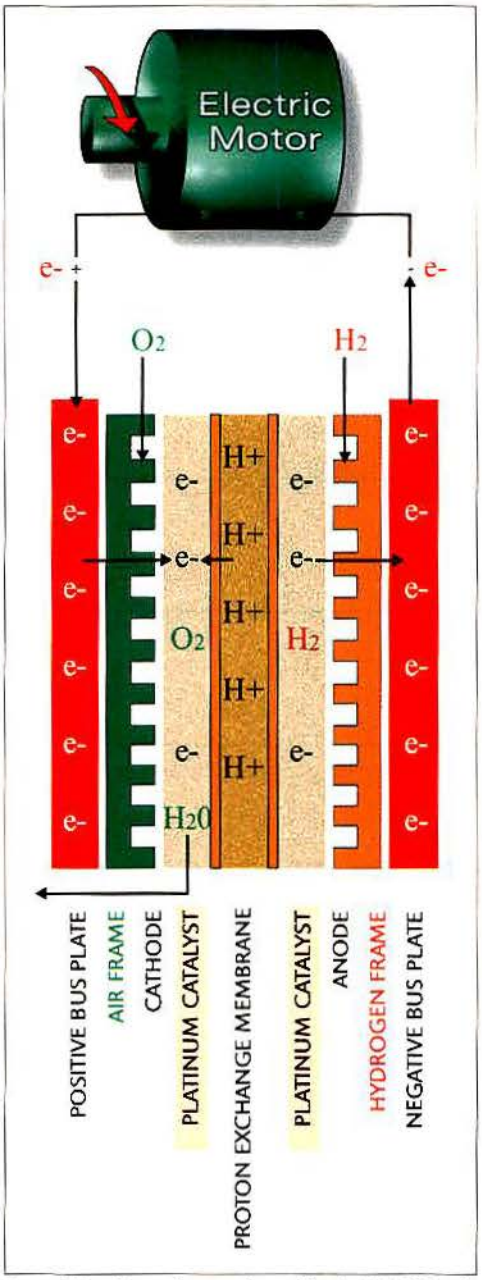
The battery as we know it will remain a "weak link" for the foreseeable future. Given its relatively short life span, the battery is also the most expensive and least reliable component of a portable device.

Innovation will be needed to satisfy the ever-increasing thirst for mobile power. The ideal battery, which would provide an inexhaustible pool of energy carried in a small package, is still far from reality. Will this miracle battery be based on the classic electrochemical concept, the evolving fuel cell or some groundbreaking new technology?

Let's focus on the emerging fuel cell and examine its suitability in stationary, mobile and portable applications.

The fuel cell

An electrochemical device that combines hydrogen fuel with oxygen, the fuel cell produces electric power, heat and water. In many ways, the fuel cell resembles a battery. Rather than applying a periodic recharge, a continuous supply of oxygen and hydrogen is supplied from the outside. Oxygen is drawn from the air, and hydrogen is carried as a fuel in a pressurized container. As alternative fuel, methanol, propane, butane and natural gas can be used.



Source: Schatz Energy Resource Center, Humboldt St. University.

The fuel cell generator converts hydrogen fuel and oxygen from air directly into dc electricity. Water is the only by-product of the reaction. The fuel cell generator, which operates at low pressures, provides reliable, clean, quiet and efficient power. It is small enough to be carried to wherever power is needed.

Energy is not generated through burning with the fuel cell; rather, it is based on an electrochemical process. There are little or no harmful emissions—the only release is clean water.

The fuel cell is twice as efficient as combustion. Hydrogen, the simplest element, is an exceptionally clean fuel. It makes up 90% of the composition of the universe and is the third most abundant element on the earth's surface. Such a wealth of fuel would provide an almost unlimited pool of energy at relatively low cost. But there is a price to pay. The fuel cell core (or stack), which converts oxygen and hydrogen to electricity, is expensive to build and maintain.

Hydrogen must be carried in a pressurized bottle. If propane, natural gas or diesel is used, a reformer is needed that will convert the fuel to hydrogen. Reformers for proton exchange membranes (the heart of the fuel cell, also called polymer electrolyte membranes) are bulky and expensive. They start slowly, and purification is required. Often the hydrogen is

Buchmann is the founder and chief executive of Cadex Electronics, Richmond, British Columbia, Canada.

delivered at low pressure, and additional compression is required. Some fuel efficiency is lost, and a certain amount of pollution is produced. However, these pollutants are typically 90% less than what comes from the tailpipe of a car.

The fuel cell concept was developed in 1839 by Sir William Grove, a Welsh judge and scientist. The invention never took off, partly because of the success of the internal combustion engine. It was not until the second half of the 20th century, when scientists learned how to better use materials such as platinum and Teflon, that the fuel cell could be put to practical use.

A fuel cell is electrolysis in reverse, using two electrodes separated by an electrolyte. Hydrogen is presented to the negative electrode (anode) and oxygen to the positive electrode (cathode). A catalyst at the anode separates the hydrogen into positively charged hydrogen ions and electrons. In the PEM system, the oxygen is ionized and migrates across the electrolyte to the anodic compartment where it combines with hydrogen. The byproduct is electricity, some heat and water. A single fuel cell produces 0.6V to 0.8V under load. Several cells are connected in series to obtain higher voltages.

The first practical application of the fuel cell system was made in the 1960s during the Gemini space program, when this power plant was favored over nuclear or solar power. The fuel cell, based on the alkaline system, generated electricity *and* produced the astronauts' drinking water. Commercial application of this power source was stalled because of the prohibitive cost of materials. In the early 1990s, improvements were made in stack design, which led to increased power densities and reduced platinum loadings at the electrodes.

Type of fuel cells

Several variations of fuel cell systems have emerged. There is the previously mentioned and most widely developed PEM system, using a polymer electrolyte. This system is aimed at vehicles and portable electronics. Several developers are also targeting stationary applications. The alkaline system, which uses a liquid electrolyte, is the preferred fuel cell for aerospace applications, including the space shuttle. The molten carbonate, the phosphoric acid and the solid oxide fuel cell are reserved for stationary applications, such as power generating plants for electric utilities. Among these stationary systems, the solid oxide is the least developed but has received renewed attention due to breakthroughs in cell material and stack designs. Table 1 below compares the most common fuel cell systems in development.

The PEM system allows compact designs and achieves a high energy-to-weight ratio. Another advantage is a quick start-up when hydrogen is applied. The stack runs at a relatively low temperature of

Table 1. Advantanges and disadvantages of the various fuel cell systems. The PEM is the most widely developed system today.

Type of Fuel Cell	Applications	Advantages	Limitations	Status
Proton Exchange Membrane (PEMFC)	Mobile (buses, cars,) portable power, medium to large-scale stationary power generation (homes, industry).	Compact design; long operating life; adapted by major automakers; offers quick start-up, low temperature operation, operates at 50% efficiency (25%–35% in system).	High manufacturing costs, needs heavy auxiliary equipment and pure hydrogen, no tolerance for contaminates; complex heat & water management.	Most widely developed, production; offers promising technology.
Alkaline (AFC)	Space (NASA), terrestrial transport (German submarines).	Low manufacturing & operation costs; does not need heavy compressor, fast cathode kinetics.	Large size; needs pure hydrogen & oxygen, use of corrosive liquid electrolyte.	First-generation technology.
Molten Carbonate (MCFC)	Large-scale power generation.	Highly efficient; uses heat to run turbines for co-generation.	Electrolyte instability; limited service life.	Well-developed; semi-commercial.
Phosphoric Acid (PAFC)	Medium to large-scale power generation.	Commercially available; lenient to fuels; uses heat for co-generation.	Low efficiency, limited service life, expensive catalyst.	Mature but faces competition from PEMFC.
Solid Oxide (SOFC)	Medium to large-scale power generation.	High efficiency, lenient to fuels, takes a natural gas directly, no reformer needed. Operates at 60% efficiency; uses heat for co-generation.	High operating temperature; requires exotic metals, high manufacturing costs, oxidation issues; low specific power.	Least developed. Breakthroughs in cell material and stack design sets off new research.
Direct Methanol (DMFC)	Suitable for portable, mobile and stationary applications.	Compact design, no compress or humidification needed; feeds directly off methanol.	Complex stack structure, slow load response times; operates at 20% efficiency.	Laboratory prototypes.

about 80°C (176°F). The efficiency is about 50%. (In comparison, the internal compaction motor has an efficiency of about 15%.)

The limitations of the PEM system are high manufacturing costs and complex water management issues. The stack contains hydrogen, oxygen and water. If dry, the input resistance is high and water must be added to get the system going. Too much water causes flooding.

The PEM fuel cell also has a limited temperature range. Freezing water can damage the stack. Heating elements are needed to keep the stack within an acceptable temperature range because freezing water can cause damage. The warm-up is slow, and the performance is poor when cold. Heat is also a concern if the temperature rises too high.

The PEM fuel cell requires heavy accessories. Operating compressors, pumps and other apparatus consumes 30% of the energy generated. The PEM stack has an estimated service life of 4,000 hours if operated in a vehicle. The relatively short life span is caused by intermittent operation. Start-and-stop conditions induce drying and wetting, which contribute to corrosion and leakage of the delicate seals. If run continuously, the stationary stack is good for about 40,000 hours. The replacement of the stack is a major expense.

The PEM fuel cell requires pure hydrogen with little tolerance for contaminates, such as sulfur compounds or carbon monoxide. Carbon monoxide can poison the system. Decomposition of the membrane takes place if different grade fuels are used.

To reduce the internal resistance of the stack, the membrane is made thin. Over time, pinholes can develop in the membrane, which cause a crossover of hydrogen. Once present, the pinholes grow in size and eventually lead to a cell failure due to electrical shorting. Testing and repairing a stack are difficult. The complexity to service a fuel cell becomes apparent when considering that a typical 150V, 50kW stack has about 250 cells.

The solid oxide fuel cell

The solid oxide fuel cell is best suited for stationary applications. The system requires high operating temperatures (about 1,000°C). Newer systems are being developed that can run at about 700°C.

A significant advantage of the SOFC is its leniency to fuel. Due to the high operating temperature, hydrogen is produced through a catalytic reforming process. This eliminates the need for an external reformer to generate hydrogen. Carbon monoxide, a contaminant in the

PEM systems, is a fuel for the SOFC. In addition, the SOFC system offers a fuel efficiency of 60%, one of the highest among fuel cells.

Higher stack temperatures demand specialized and exotic materials, which add to manufacturing costs. Heat also presents a challenge for longevity and reliability because of increased material oxidation and stress. However, high temperatures offer a benefit by enabling cogeneration by running steam generators. This improves the overall efficiency of this fuel cell system.

An effort exists to further explore the potential of the alkaline fuel cell. Although larger in physical size than the PEM system, the alkaline fuel cell has the potential to lower manufacturing and operating costs. Water management is simpler, no compressor is usually needed and the hardware is cheaper.

Applications

Fuel cells may soon compete with batteries for portable applications, such as laptop computers and mobile phones. However, today's technologies have limitations in meeting the cost and size criteria for small portable devices. The cost per watt-hour is less favorable for small systems than large installations.

Note the cost to produce 1kW of power. The investment to provide 1kW of power using rechargeable batteries is around $7,000. This calculation is based on 7.2V; 1,000mAh NiCd packs costing $50 each. High energy-dense batteries that deliver fewer cycles and are more expensive than the NiCd.

The high cost of portable power opens vast opportunities for the portable fuel cell. At today's cost of $3,000 to $7,500 per kilowatt, however, energy generated by the fuel cell is only marginally less expensive than that generated by conventional batteries.

A fuel cell for portable applications would not necessarily replace the battery in the equipment but could serve as a charger that is carried separately. The feasibility to build a mass-produced fuel cell that fits into the form factor of a battery is still a few years away.

The advantages of the portable fuel cell are: high energy density (as much as five times that of a Li-ion battery); environmental cleanliness, fast recharge and long runtimes. In fact, continuous operation is feasible. Miniature fuel cells have been demonstrated that operate at an efficiency of 20% and run for 3,000 hours before a stack replacement is necessary. There is, however, some degradation during the service life of the fuel cell. Portable fuels cells are still in experimental stages.

Advantages, limitations

Ironically, the fuel cell will not eliminate the chemical battery but will promote it. The fuel cell needs batteries as a buffer. For many applications, a battery bank will provide momentary high current loads and the fuel cell will keep the battery fully charged. For portable applications, a supercapacitor will improve the loading characteristics and enable high current pulses.

The fuel cell will find applications that lie beyond the reach of the internal combustion engine. Once low-cost manufacturing is feasible, this power source will transform the world and bring great wealth to those who invest in this technology.

The fuel cell may be as revolutionary in transforming technology as the microprocessor has been. Once fuel cell technology has matured and is in common use, our quality of life will improve and the environmental degradation caused by burning fossil fuel will be reversed. However, the maturing process of the fuel cell may not be as rapid as that of microelectronics. ■

This article is an excerpt from *Batteries in a Portable World – A Handbook on Rechargeable Batteries for Non-Engineers* (second edition). In the book, Buchmann evaluates the battery in everyday use and explains their strengths and weaknesses in laymen's terms. The 300-page book is available from Cadex Electronics through book@cadex.com, tel. 604-231-7777 or most bookstores. For more details on the book visit www.buchmann.ca.

Table 2. Cost comparison to generate 1kW of energy. This takes into account the initial investment, fuel consumption, maintenance and eventual replacement of the equipment.

Energy source	Investment of equipment to generate 1kW	Lifespan of equipment before major overhaul or replacement	Cost of fuel per kWh	Total cost per kWh, incl. fuel, maintenance & equipment replacement
NiCd For portable use	$7,000 based on 7.2V, 1,000mAh at $50/pack	500h 1 based on IC discharge	$0.15 electricity for charging	$7.50
Gasoline engine For mobile use (134hp)	$30 based on $3,000/100kW	4,000h	$0.10	$0.14
Diesel engine Stationary use (134hp)	$40 based on $4,000/100kW	5,000h	$0.07	$0.10
Fuel cell Portable use Mobile use Stationary use	$3,000–$7,500	 2,000h 4,000h 40,000h	 $0.35 $0.35 $0.35	 $1.85–$4.10 $1.10–$2.25 $0.45–$0.55
Electricity From utility grid	All inclusive	All inclusive	$0.10	$0.10

Lightning technology

Alltec is an organization on the cutting edge of lightning and grounding technology. Its services include: systems CAD designs, installation and ground system testing.

WWW.ALLTECCORP.COM

Battery testing

The Xpresscheck-Pro from **Astratec Electronics** performs a health scan on any two-way battery in less than three minutes. The unit tests for battery impedance, charge acceptance, defective cells and current charge level.

WWW.ASTRATECELECTRONICS.COM

Base station controller

Avtec's base station controller is a microprocessor–based remote radio controller capable of providing voice communications and radio control from a central dispatch office. Owner-configurable parameters allow the BSC to be deployed in many operational environments.

WWW.AVTECINC.COM

Receiver system

The Coyote from **Berkeley Varitronics Systems** features hot-swappable components allowing for versatile field use, including removable, independent receiver modules, GPS receiver, rechargeable Li-ion battery and compact ATA flash.

WWW.BVSYSTEMS.COM

Battery analyzer

The **Cadex** 7400 programmable battery analyzer and charger features Quicktest to test a battery's state-of-health in three minutes. The 7400 supports more than 700 custom-built battery adapters and offers 16 service programs.

WWW.CADEX.COM

Fixed wireless products

The i-WLL Trailblazer products from **Carlson Wireless Technologies** are broadband fixed wireless solutions for rural and remote sites. They feature plug-and-play simplicity, CDMA spread-spectrum technology for telephone, high-speed Internet, leased line, Ethernet bridge and 2.4GHz.

WWW.WIRELESS-TELEPHONE.COM

IP server technology

Dataradio IP gives you an easy and efficient way to connect a variety of software applications to a Dataradio wireless data network. Any Dataradio mobile equipped with Dataradio IP server technology will be able to access host-based applications without modification of the mobile environment.

WWW.DATARADIO.COM

Portable radio

The Guardian portable radio from **Datron World Communications** offers the P-25 FDMA common-air interface for complete interoperability in radio service pools incorporating the P-25 standard. It is also fully backward-compatible with conventional wideband FM systems.

WWW.DTWC.COM

Base station accessory kit

The 431-BAK accessory kit from **IDA** is designed for the APCO 25 mobiles KMR-25 from King Communications or the EFJohnson RS5300. The kit allows full-function wireline control via IDA's 24-66MSK digital remote console.

WWW.IDACO.COM

Battery charger

iTECH's (Intelligent Technologies) iQ-pac offers three charge rates, pulse conditioning charge, constant current charge, a data port that connects to a PC for battery performance tracking and a LCD to display battery capacity.

WWW.ITECHENG.COM

VoIP products

JPS Communications manufactures voice-over-IP products optimized for remote radio applications, crossband interfaces that interconnect multiple radio bands and receiver comparators that vote analog and trunking signals.

WWW.JPS.COM

Self-contained radio site

The OpenSky self-contained radio site from **M/A-COM** contains trunking base station radios and other network routing and RF equipment to provide cellular coverage. The equipment is housed in an aluminum shelter with air conditioning.

WWW.MACOM.COM

Console system

Moducom's Ultracom 2000 E9-1-1 and radio dispatch console system is cost-effective, all-digital, 100% user-programmable with pop-up windows and built-in diagnostics. It is a single software application combining radio dispatch and E9-1-1; just add hardware. Free software upgrades are available.

WWW.MODUCOM.COM

Speaker microphone

Shure Communications' 810 Modulink speaker microphone features a sealed, gasketed splash-proof design with a rugged Armodur casing. It also offers a million-cycle, silver-plated PTT switch and meets the MIL-STD 810E driven-rain test.

WWW.SHURECOMM.COM

Tower-top amplifiers

The SD210 and SD235 series of low intermod (285dBm), VHF, exposed-dipole, external harness, single- and dual-array antennas from **Sinclair Technologies** are available with bi-directional, offset or omnidirectional patterns.

WWW.SINCTECH.COM

Control consoles

Telex Communications manufactures Vega control consoles and is now offering the C-1610 six-line tone consoles in a 19" rack-mount version. It is available in two, four or six lines with multiple microphone inputs and two 5W speakers.

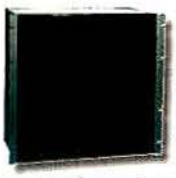
WWW.VEGA-SIGNALING.COM

Passband filter

TX RX Systems' UHF U-selector offers 40dB of selectivity, 1MHz from the edge of the passband while fitting nicely into a 19" rack.

WWW.TXRX.COM

Common controller



The model 4020 from **Zetron** is a 20-channel common controller that supports as many as six series 4000 operating positions including the model 4217NT dispatch workstation, the 4118 rack-mount button console and the 4018 desktop button console. The architecture and feature set of the 4020 are identical to that of the 4048.

WWW.ZETRON.COM

Are you willing to take a risk?

Investing in the stock market is a gamble. So is updating your business plan. But sometimes these things need to be done. Sometimes businesses need to head down a new road filled with more opportunities in the name of growth.

Jeff Grazi of Grazi Communications in Denver, took that gamble. Grazi added UHF trunking to his business portfolio because he believed there were new opportunities for growth in that field compared to his conventional repeaters, paging and communications consulting services. In the October 2000 issue of *MRT*, Grazi wrote an article describing how his company had made UHF trunking profitable. In the article, he discussed licensing, technology and infrastructure problems he had faced when he started providing UHF trunking service. Since that article, Grazi has faced more challenges. After all, no one said taking a gamble was easy.

The biggest challenge for Grazi has been transferring conventional subscribers to the trunked UHF system.

First of all, growth is slow. Don't start your UHF trunking venture thinking that you will see the money flow within two weeks, or even a month. After three years Grazi Communications is still expanding its system. It is currently moving into Colorado Springs, CO. While growth has been slow in the two-way industry, Grazi hopes this new expansion will generate more growth in subscribers, both new and conventional, who turn to trunked UHF.

The biggest challenge for Grazi has been transferring conventional subscribers to the trunked UHF system. It's difficult to get customers to switch when the original equipment they have is already paid for, whereas when they switch over to a trunked system, they have to buy all new equipment. Most conventional equipment is not compatible.

"If it wasn't for the expense of switching," Grazi said, "people would move over quicker."

An unforeseen problem has recently manifested for Grazi in his new venture. He discovered that some equipment that claims to be compatible isn't—namely portables and mobiles. A couple of weeks ago a customer had bought some equipment that purported to be compatible, but wasn't. Now, as a lesson learned, Grazi is careful about what equipment is *supposed* to do and what it *actually* does.

One other note to make on equipment is cost. Controlling equipment is more expensive and more complicated to maintain than the conventional equipment.

Overall, Grazi is glad he ventured into the UHF trunking business. He was surprised at first that the return on investment wasn't immediate, but says eventually he will see a profit (in about two more years). "It's kind of like the stock market. You don't take your money out if stocks go down because you realize eventually it will pay off," Grazi said. "I felt like this was the next frontier for technology and I wanted to get a head start," Grazi said.

If you have changed your business strategy or have found a new use for a traditional product, please email your story to Kari Taylor, associate editor, at **ktaylor@intertec.com.** ■

Securicor reveals pending sale for $36 million

In its May 31 statement of interim financial results, United Kingdom–based Securicor described heavy losses at its Securicor Wireless subsidiary and revealed its intent to sell the business.

The most likely possibilities seem to include the sale of a small fraction of the company, including the land mobile radio business, to Kansas City, MO-based Midland Consumer Radio. A source close to the company said that the sale of the land mobile radio business could close by the end of June.

The larger portion of the business might be purchased in a leveraged buyout led by the company's chairman, Robert Shiver. Tokyo-based Hitachi Denshi also has been mentioned as a possible buyer.

Securicor Wireless has its headquarters in New York, an operations center in Kansas City, MO, (in the same building with Midland Consumer Radio) and a research and development facility in Bath, United Kingdom. The company's enterprises include the land mobile sales and distribution business once known as Midland LMR; a 220MHz network operations and airtimes sales business once known as Roamer One; and mobile data and GPS hardware and software products once known as DataExpress.

A fourth part of the company, Securicor Wireless Technologies (formerly known as Linear Modulation Technology), located in Bath, involves intellectual property rights to a modulation method ("linear modulation") and electronic chip configurations that facilitate the manufacture of linear modulation equipment.

Securicor Wireless also owns more 220MHz spectrum than any other FCC licensee.

Securicor Wireless posted sales of $8 million during the six-month period ending on May 31 and a loss of $10.4 million for the period, "a clearly unsatisfactory trading performance," the Securicor financial statement reads. The loss is up from $4 million for a similar period a year ago.

Securicor Wireless' enterprises include the business once known as Midland LMR. Above: Titan radio.

"Due to the length of time required before it can be brought into profit and because of our focus on building a global security business, we have decided not to retain the company," the statement reads. "Accordingly, we are now in advanced negotiations for its disposal, a detailed letter of intent reflecting a sale price in the region of $36 million having been signed earlier in the month."

Elliott Hamilton, senior vice president at Strategis Group, said that the price cited by Securicor couldn't be justified by the revenue stream.

"It has to be the technology," Hamilton said.

Hamilton said that Securicor Wireless' customer base also would have some value, especially the airtime customers, although the number of customers hasn't been publicized. He said it's possible that no one acquiring the company could benefit from all four of Securicor Wireless' businesses and, thus, one or more might be spun off after an acquisition.

"It's quite a collection of technologies and operating concerns for one company," Hamilton said.

The two-way radio industry could benefit from consolidation, Hamilton said. "I hope that the acquiring company is not some new company deciding to enter the industry. That's not what this industry needs. Eventually, some company is going to have to start making money."

Securicor Wireless currently deploys linear modulation exclusively in its 220MHz systems. Free from Securicor, the company might deploy newer digital technology or lower-cost analog FM. Alternatives to linear modulation might give the company ways to deliver wireless communications with reduced manufacturing and operating costs and attractive end-user pricing that have seemed elusive.

Hitachi is said to have developed a method for deploying digital technology compatible with the 220MHz spectrum. Sun Valley, CA-based DX Radio Systems is testing an analog FM technology that also could be used in the 220MHz spectrum. *–D.B.*

Scanning ...

Sonik Technologies, Vista, CA, has acquired the Broadband Wireless Spread Spectrum product line of RadioConnect of Torrance, CA.

Sal Communications, ShenZen, China, has agreed to be the exclusive distributor in China for **Relm Wireless**, West Melbourne, FL.

Cadex Electronics, Vancouver, Canada, is expanding into Europe by opening an office in the United Kingdom.

International Wireless Telecommunications-Europe will use IWTA's Fourth European Business Wireless Congress to introduce Europe to the industry association.

J.B. Hunt Transport Services, Lowell, AR, ordered 17,000 FleetView Trailer Monitoring Systems from **Terion**, Melbourne, FL.

Thales Communications, Rockville, MD, (formerly Racal Communications) received the Technology Council of Maryland's Information Technology Product of the Year award for its hand-held radio for the military's Special Forces.

Digital logger provides start-stop control

E.F. Johnson has teamed up with **EXACOM** to provide a digital logging recorder for use on the Multinet trunked radio system by EF Johnson. The Hindsight-net digital recorder is integrated with the Multinet system using an interface adapter. The logger provides complete start-stop control and identification of unique ID, group ID, home and site IDs associated with the radio system audio channels. Features of the digital recorder include the ability to maintain eight to 128 channels per recorder, an install-recall buffer that has a capacity of 2,000 channel hours, and archival storage that can support more than 4,000 channel hours per recorder.

WWW.EFJOHNSON.COM
WWW.EXACOM.COM

Software requires no physical connection

The ArchiveReview software from **Eventide** can search and play off-site with neither a physical connection to the recorder nor the need to re-record the data to analog audio tape or digital PC format. Original archives recorded on the logger are virtually tamper-proof. Unlike audiocassettes and .wav files, the only way to edit or alter the archive data is to destroy the media. Therefore, it is often imperative that the original archives be available in case of dispute. The software, in combination with a DVD-RAM or DDS archive drive, can be installed on any PC or laptop computer. It looks and loads like other Windows-based programs and requires a minimal amount of hard disk space. An optional foot control is available to facilitate the transcription of archives.

WWW.EVENTIDE.COM

System uses WIN2000

Dynamic Instruments' digital recorders use a WIN-2000 operating system. The recorders locate, retrieve, review, duplicate and distribute calls through integrated hardware and software tools. Recording can be as few as eight and as many as hundreds of channels through networking. Archiving choices include MO, DVD or DAT media.

WWW.DYNAMICINST.COM

Recording system offers disk array

Dictaphone's Prolog and Networked Guardian communications recording systems feature a seven-disk array offering organizations on-line access for as long as seven months of recorded voice communications. The system works by recording on one hard disk after another, until all seven disks are filled. Then, the system operates as a circular buffer and begins recording over the audio on the first hard disk. Disks can connect to a single recorder, providing about 9,000 channel hours of unattended recording.

WWW.DICTAPHONE.COM

Logger supports analog, digital

The DVL-24 digital voice logger from **JEI Communications** offers instant recall and archival recording of as many as 24 recording channels. A built-in 6.4" flat-panel monitor permits viewing details on 18 recordings at one time. This logger supports analog and digital phone service, as well as conventional and trunked radio service. A locking front panel conceals the archival drives, the power switch and the monitor switch. An optional writable CD or DVD allows users to make copies of specific recordings in a .wav file format.

WWW.JEI-INC.COM

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Product Encore

Of the new products in the November 2000 issue, this one generated the biggest reader response. For more information on this product, log on to www.optoelectronics.com.

Frequency counter decodes DTMF

The Multicounter CD 100 from **Optoelectronics** combines a 0.5ppm TCXO frequency counter with a CTCSS, DCS, LTR and DTMF decoder. Key up an analog radio, and the frequency counter locks onto the signal and then displays the transmit frequency as well as the tone or code for that frequency. A two-line LCD with EL backlight improves operation in low-light conditions. It operates in the 10MHz–1GHz frequency range and is powered by built-in NiCd batteries.

WWW.OPTOELECTRONICS.COM

Fleet manager uses GSM, PCS network

Trimble's Crosscheck GMS 1900 mobile communicator for fleet management combines a GPS receiver, GSM, PCS technology and IQ Eventengine firmware in a single module. The move to this single communications unit can bring a reduction in cost and installation time to operators. This product sends GPS data and messages from the mobile unit to a base station running Fleetvision or third-party software.

WWW.TRIMBLE.COM

Cable improves radio coverage

Andrew's Radiax RXL-4.5-1 is a 6/8" coupling-mode cable suitable for installation in buildings and in tunnels where speed of installation is required. This smaller-size cable is easy to install and offers lower insertion loss. The cable features a corrugated, welded copper outer conductor over a low-density, foam-covered inner conductor. Holes milled in the corrugation peaks of the outer copper conductor produce the radiating cable effect.

WWW.ANDREW.COM

Headset features wrap-around design

Eartec's Monarch headset features a flexible backhand molded with PBT, a polymer developed for use in the manufacturing of automobile bumpers. The wrap-around design offers a low fatigue, comfortable fit even when worn with safety helmets. Each headset includes an inline push-to-talk assembly rated for 10,000 operations and a connector for a portable transceiver.

WWW.EARTEC.COM

Vertical pattern yields wireless coverage

Radio Frequency Systems' base station/hub antenna provides two-way broadband wireless data and Internet connection to homes and businesses as well as to mobile wireless subscribers. Developed for two-way MMDS applications in the 2.4GHz–2.7GHz microwave frequency range, the antenna uses radiating element technology that rejects interference from cross-polarized sources. The unit's vertical patterns are tailored to conform to a cosecant squared power envelope, which produces the right amount of null fill and upper sidelobe suppression.

WWW.RFSWORLD.COM

System supports LAN card

The Rocky Unlimited mobile computing system from **AMREL** offers new features including an Intel Pentium III 700MHz processor, a mini PPCI slot and expansion capabilities. This system also supports a coexisting LAN card/fax modem, CDPD and COM ¾ card. Standard features include temperature resistance, 89-key backlit keyboard, two type II or one type III PCMCIA slots and a removeable HDD.

WWW.AMREL.COM

Amplifier provides as much as 150W

The LMS amplifier from **TPL Communications** has been mechanically redesigned for easier serviceability, if needed. The amplifier is engineered to provide as much as 150W of power in any band between 35MHz and 960MHz, in a compact package using only 7" of vertical rack space. Input power ranges from 50mW to 50W are available. This product is self-contained with a switching power supply and includes a front-panel digital meter and LED indicators for local monitoring of important test conditions.

WWW.TPLCOM.COM

Transmitter offers weather resistance

The Quick Talk model from **Ritron** integrates digital voice recording technology with a PC-programmable 6W radio transmitter. This weather-resistant transmitter monitors as many as two contact closure/switch inputs and transmits custom voice messages over any VHF or UHF radio system. Line-of-sight coverage can be achieved through a radio repeater.

WWW.RITRON.COM

Radio migrates easily

Motorola's HT1550 XLS Professional Series portable radio features dual-mode operation capability that allows users to switch between LTR and conventional modes at the touch of a button, and makes migration easy for growing businesses. Additional features include MDC signaling, four-line alphanumeric display, as many as 160 conventional channels and as many as 15 trunked zones with 16 talkgroups each.

WWW.MOTOROLA.COM

Vocoder useful where bandwidth is premium

The AMBE+2 from **Digital Voice Systems** performs under bit errors and acoustic background noise conditions. This product is useful for mobile radio, secure voice, satellite communications, computer telephony and other digital voice and storage applications where bandwidth is at a premium.

WWW.DVSINC.COM

Repeaters come tuned, assembled

Topaz3 offers four single user, low-power repeaters. Two basic models (the SR-125V VHF and SR-125U UHF) and two models with built-in six-cavity duplexers (the SR-125DV and SR-125DU) are offered. Each of the repeaters include two fully programmed Maxon SD-125RF link modules and feature one CTCSS tone, a programmable repeater time-out timer to prevent lock-up and excessive transmissions and TX hang-on. All of the repeaters are completely assembled, tuned and ready for wall-mount or desktop use.

WWW.TOPAZ3.COM

July

15–18: Forestry Conservation Communications Association National Conference, Olympia, WA. **www.mashell.com/~roblee/fcca.htm**.

17–18: European Business Wireless Congress, sponsored by the International Wireless Telecommunications Association, Prague. Contact: Ryan Cleveland, 202-331-7773.

August

5–9: Association of Public-Safety Communications Officials–International (APCO) National Conference, Salt Palace Convention Center, Salt Lake City. Contact: 904-322-2500 or **www.apco-intl.org**.

September

11–14: PCIA GlobalXChange, sponsored by the Personal Communications Industry Association, Los Angeles Convention Center, Los Angeles. Contact: 703-739-0300 or **www.pcia.expoventure.com**.

12–13: C.O.P.S. West, produced by the California Peace Officers' Association, Ontario Convention Center, Ontario, Canada. **www.copswest.com**.

19–22: Private Wireless Spectrum Management Conference & Expo, sponsored by Industrial Telecommunications Association, the Council of Independent Communications Suppliers and the USMSS, Grand Hyatt Hotel, Washington. Contact: Ray Wisniewski at 703-528-5115 or email: **ray@ita-relay.com**.

November

6–8: Canadian Wireless, sponsored by the Canadian Wireless Telecommunications Association, Metro Toronto Convention Center, Toronto. Contact: 613-233-4888, ext. 102, or **www.cwta.ca.**

6–11: Communications Marketing Conference, DoubleTree Hotel Tucson-Reid Park, Tucson, AZ. **www.commktga.com**.

12–15: AMTEX 2001, sponsored by the American Mobile Telecommunications Association, Wyndham Miami Biscayne Bay, Miami. Contact: 202-331-7773. **www.amtausa.org.**

12–15: IWTA 2001 Expo, sponsored by the International Wireless Telecommunications Association, Wyndham Miami Biscayne Bay, Miami. **www.iwta.org.**

2002

February

19–22: NATE, sponsored by the National Association of Tower Erectors, Orlando, FL. Contact: 888-882-5865 or **www.natehome.com.**

March

7–10: Entelec 2002, George R. Brown Convention Center, Houston. **www.entelec.org**.

April

24–26: International Wireless Communications Expo, co-sponsored by *Mobile Radio Technology*, Las Vegas Convention Center, Las Vegas. **www.iwceconexpo.com**.

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"The Times They Are A-Changin'"

Hello. My name is Roger. I have a couple of confessions to make. It is time for me to be honest with you.

In my last column I told you a bit about myself. Now, I must offer you an insight into the inner Roger.

Confession #1 — When I was in college I played in a rock band. It was the '60s, and my life revolved around my 1964 vintage Fender Stratocaster guitar. So, my public admission to you is (drum roll): I'm an old rocker who just never grew up. No long hair then. No hair now.

Confession #2 — When I was in the U.S. Air Force, I once had the nickname "The Whistler." I never realized it, but often a situation would remind me of a song. And before I knew it, I would whistle it. I was even known to play the air guitar when I thought no one was watching. I was caught more than I care to admit.

Why do I need to mention this? Well, you see I want to learn more about what is important to you, the reader of *Mobile Radio Technology*. So, I invited three highly respected members of the mobile radio community to lunch. Although my purpose was to ask questions, I ended up becoming the "fly on the wall." My guests conversed as friends who haven't seen each other in some time. The "war" stories flew. I sat there, entranced, listening to them discuss what the mobile radio world used to be and what it is today. I asked a few questions, but I didn't need to. I felt like "Grasshopper" in the old TV show *Kung Fu*.

Educate your customer and be ready to back up your product or service.

No ponytails, then or now

As I listened, I noticed that two of my guests had ponytails. My envy, I hope, wasn't too obvious. I had wanted to grow a ponytail when I was in the rock band. But my dad thought that "only hippies" grew them. I guess my clothes didn't send the message, "Hey, Dad I *am* a hippie." So, because I was a poor musician and student living at home, I acquiesced to no ponytail. Today, I couldn't grow a ponytail if I started off as Secretariat.

After a highly enjoyable and educational lunch, I found myself whistling Bob Dylan's "The Times They Are A-Changin'." No air guitar. Heck, I had to keep my hands free to drive the car and be ready to answer my cellphone.

(OK. *Confession #3* — My pet peeve, besides people who haven't figured out how to use a turn signal, is people driving their cars attempting to use cellphones at the same time.)

The times, they did change

The discussion of my three colunchers made it clear that the mobile radio industry has undergone tremendous change. Of the many changes they discussed, the one that stuck out the most was how people do business today compared to 10, and even five, years ago. The same can be said for just about any industry that deals with technology. The creation of *need* drives the change in other technology markets. That need could be for a new application or capability, or the need to be "now." (As in, "It's new. I have to have it *now*.")

In the mobile radio market, the need is much the same now as it was 10 years ago. Technology always has an impact, but not to the degree, say, that mobile telephony has seen. The real change is how people do business.

Roger's quiz

Do you do business differently today than in the past?

- ❑ Yes
- ❑ No
- ❑ Can't remember that far back

Do you offer the same product lines and/or services that you did in the past?

- ❑ Yes
- ❑ No
- ❑ Still waiting for the tubes to warm up

Are your clients as technically oriented as they were in the past?

- ❑ Yes
- ❑ Sort of
- ❑ Can't tell a gigahertz from a megahertz

This is a short quiz, but I think you can catch where I'm going. Of course you do not do business the way you used to. No matter whether you are a dealer or an operator (or both), to survive, you have had to change.

At IWCE 2001, I talked with a number of folks about their businesses and how they are approaching them. A few appeared to have stayed the course with little change. As one individual put it, "It's a good ol' boys network, anyhow." This individual was in the minority. Most have had to deal with what technological changes have occurred and the level of experience and expertise their clients have.

The magic answer

No matter the problem, I suppose it's human nature to look for the path of least resistance or the easy answer. Well, I'm here to offer Roger's rule for doing business: Educate your customer and be ready to back up your product or service.

Is this too obvious? Most answers are. Yet, there are those, and you've met them, who take the "They have to come to us because where else are they going to go?" approach. Use this approach, and one day the customer will tell *you* where to go. Well, I feel a song coming on.

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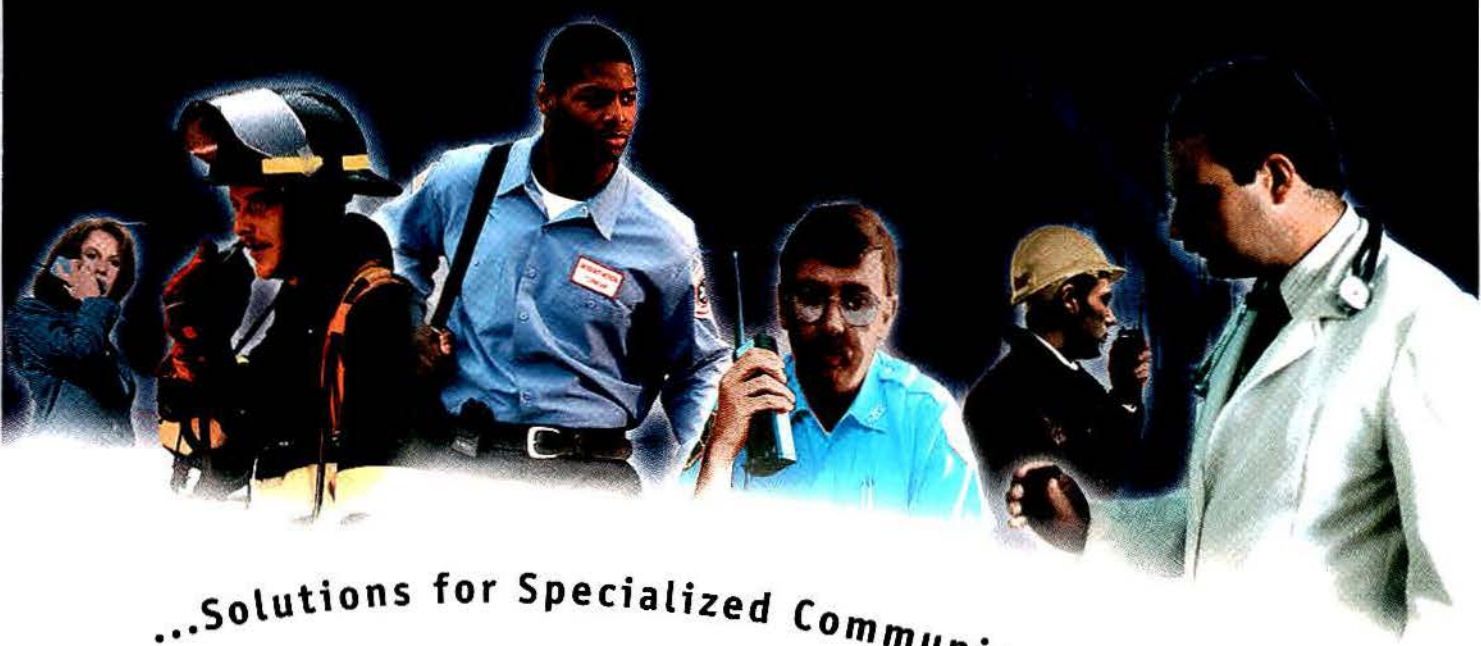

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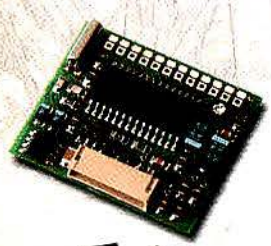

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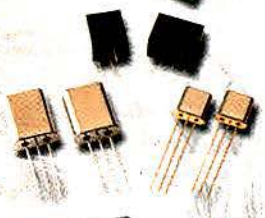

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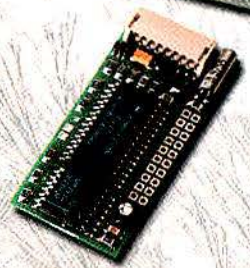

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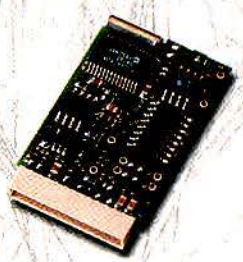

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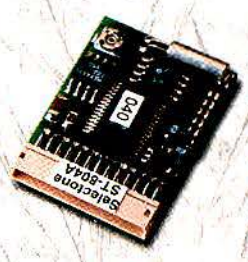

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